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Edward Jenner
from his sincere & affectionate
friend
William Lawrence
October 1807

A
SHORT SYSTEM
OF
COMPARATIVE ANATOMY,

TRANSLATED FROM THE GERMAN OF

J. F. BLUMENBACH,

PROFESSOR OF MEDICINE IN THE UNIVERSITY OF GOETTINGEN.

BY

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WITH

NUMEROUS ADDITIONAL NOTES,
AND AN INTRODUCTORY VIEW OF THE CLASSIFICATION
OF ANIMALS,

BY THE TRANSLATOR.

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TO

Sir JOSEPH BANKS, K.B. P.R.S. &c. &c.

WHOSE LABOURS HAVE SO MATERIALLY CONTRIBUTED

TO THE

ADVANCEMENT OF NATURAL HISTORY;

AND WHOSE MUNIFICENT PATRONAGE HAS SO SIGNALLY
PROMOTED EVERY BRANCH OF SCIENCE;

THIS HUMBLE ATTEMPT

TO FACILITATE THE STUDY OF

COMPARATIVE ANATOMY,

IS MOST RESPECTFULLY INSCRIBED,

AS AN

INDIVIDUAL TRIBUTE OF THAT ESTEEM AND ADMIRATION
WHICH ARE SO UNIVERSALLY FELT AND EXPRESSED
BY THE LOVERS OF SCIENCE,
IN ALL PARTS OF THE WORLD:

BY HIS MOST OBEDIENT SERVANT,

WILLIAM LAWRENCE.

John-Street, Adelphi,
April, 1807.

PREFACE.

THE object of the preſent publication is to exhibit a conciſe, but at the ſame time general and ſyſtematic view, of the ſtructure of the body throughout all claſſes of the animal kingdom. This ſcience, which is very aptly denominated, *Comparative Anatomy*, affords the moſt eſſential aid in elucidating the ſtructure of the human body, and in explaining the doctrines of phyſiology.

The want of any organ in certain claſſes of animals, or its exiſtence under different modifications of form, ſtructure, &c. cannot fail to ſuggeſt moſt intereſting concluſions concerning the office of the ſame part in the human ſubject. Thus our phyſiological reaſonings, which muſt neceſſarily be partial and incomplete, when deduced from the ſtructure of a ſingle animal or claſs, are extended and corrected by this general comparative ſurvey, and may, therefore, be relied on with the greater confidence. We are indebted to ſuch inveſtigations for the diſcovery of the circulation and of the lymphatic ſyſtem; for the elucidation of the functions of digeſtion and generation: indeed, there is no branch of anatomy or phyſiology which has not received moſt material benefit from the ſame ſource. Hence Haller has very juſtly obſerved, that "phyſiology has been more illuſtrated by Comparative Anatomy, than by the diſſection of the human body."

The ſtudy of Comparative Anatomy is moreover of the greateſt importance in its connection with veterinary ſcience, and with that highly intereſting purſuit, natural hiſtory. It would be an affront to my readers to enlarge upon its utility in the former point of view; but I may be allowed to obſerve on the latter ſubject, that anatomical ſtructure forms the only ſure baſis of a natural Claſſification of the animal kingdom; and that any arrangement not founded on this ground-work will lead us into the moſt groſs and palpable errors.

Laſtly, this ſtudy opens to the mind a great ſource of intereſt and ſatisfaction, in exhibiting ſuch numerous and undeniable proofs of the exertion of contrivance and deſign in the animal ſtructure: in diſplaying thoſe modifications of particular parts and organs, by which they are adapted to the peculiar circumſtances of the animal, and become ſubſervient to its wants, its neceſſities, or its enjoyments.

The importance of the ſubject from the above mentioned circumſtances is now ſo fully recognized, that it begins with juſtice to be conſidered as an eſſential part of a regular medical education. Public lectures have been delivered on it for ſome years in Germany and France; and lately the example has been followed in this metropolis. Yet a ſhort elementary treatiſe on the ſubject ſtill remains a deſideratum *; and I have undertaken the tranſlation of the preſent work, in order to ſupply this defect. The author is well-known throughout Europe for his ſucceſsful labours in Phyſiology and Natural Hiſtory; and has a particular claim on the public gratitude, for the excellent elementary treatiſes, which he has publiſhed, on different branches of the profeſſion. The preſent work will not, I truſt, detract from his well-earned reputation.

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* Blasius has given a collection of the writings of ſeveral authors on the anatomy of particular animals, in one volume 4to, entitled "*Anatomia Animalium Figuris variis illuſtrata*, Amſtel. 1681, which may ſtill be conſulted with advan-

If any reader ſhould think that the author has treated the ſubject with too much brevity; the defect is compenſated by the numerous references to ſources of more detailed information, in the works of the beſt and moſt approved preceding writers; parti-

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advantage, particularly on account of the plates. Cuvier's *Leçons d'Anatomie comparée*, in five large octavo volumes, form a very valuable and uſeful repoſitory of facts in Comparative Anatomy; but the ſubject is treated at ſuch length, and with ſo many unintereſting details, that the book is by no means adapted for the uſe of ſtudents. There is a moſt admirable deſcription of the anatomy of the claſs Birds in the fourth volume of Dr. Rees's *New Cyclopædia*, from the pen of Mr. Macartney: and it were much to be wiſhed, that we had an account of the whole animal kingdom from the ſame able hand.

cularly to ſuch as have given good plates of the parts, which they deſcribe. Theſe quotations may afford aſſiſtance even to thoſe, who have made ſome progreſs in the ſtudy.

I have taken the liberty of adding notes to ſuch parts as appeared defective either from omiſſion, or too great conciſeneſs; and I have placed theſe at the end of each chapter. Many of theſe are derived from CUVIER's work, which I acknowledge in this general manner, to ſave the trouble of numerous references.

A ſhort view of the Claſſification of Animals is prefixed, for the accommodation of ſuch readers as may not not underſtand enough of natural hiſtory. BLUMENBACH has publiſhed a moſt excellent "*Manual of Natural Hiſtory*," in German; and there is a ſimilar work in French, by CUVIER, entitled "*Tableau Elementaire de l'Hiſtoire Naturelle*;" either of which will be found very uſeful to beginners.

W. LAWRENCE.

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INTRODUCTION,

CONTAINING

A SHORT ACCOUNT OF THE CLASSIFICATION OF ANIMALS, IN WHICH THE TECHNICAL TERMS ARE EXPLAINED:

BY THE TRANSLATOR.

IT is neceſſary for me to make a few remarks on the claſſification of this animal kingdom; as the terms employed in the work differ occaſionally from thoſe of the Linnean ſyſtem, which has been hitherto chiefly followed in this country. And, independently of this circumſtance, ſuch of my readers as have not particularly attended to the ſtudy of natural hiſtory, may derive aſſiſtance and information from a ſhort ſketch and explanation of the arrangement of animals according to their anatomical ſtructure, with an enumeration of the chief genera in each order.

That the Linnean ſyſtem is expoſed to numerous and well-grounded objections, and that in many inſtances it diſregards anatomical ſtructure, which ſhould form the baſis of a natural claſſification, will be readily allowed by the moſt ſanguine admirers of it's illuſtrious author. Yet it muſt be remembered, that the general adoption of this method renders it deſirable to deviate from it in as few inſtances as poſſible; ſince the introduction of new orders and names muſt neceſſarily create difficulty and confuſion in the ſtudy of the ſcience. The French zoologiſts, whoſe ſucceſsful labours in the advancement of natural hiſtory muſt be acknowledged with every due tribute of reſpect, have carried the rage of innovation too far, in the univerſal rejection of the Linnean method, and the unneceſſary multiplication of new orders and genera. The defects or errors of any ſyſtem could not cauſe ſo much perplexity and inconvenience as the want of a generally received ſtandard, and the unlimited licence, in which every individual indulges, of fabricating new claſſifications and arrangements. To judge by ſome recent works, we ſhould be led to ſuppoſe, that the merit of a ſyſtematic arrangement of animals does not conſiſt in the ſimplicity or intelligibility of the ſyſtem; but is in proportion to the number of newly-created terms.

The *Zoologie Analytique* of DUMERIL, (Paris, 8vo. 1806) appears to have been conſtructed on this principle; and recals to our mind the juſt and forcible obſervations of BLUMENBACH, as expreſſed in his admirable work on *The Varieties of the Human Species.* "Alieniſſimus quidem "ſum a noſtericorum multorum novandi pruritu, qui "rebus naturalibus, quæ pridem nominibus ſuis vel in "vulgus notiſſimis, inſignes ſunt, nova imponendo, miri- "ficé ſibi placent: qui quidem onomatopoietarum luſus "ingentem ſtudio hiſtoriæ naturalis calamitatem attu- "lit." Edit. 3rd, p. 16.

Animals may be diſtributed into two grand diviſions: thoſe which have a vertebral column, and red-blood: and thoſe which have no vertebræ, and are white-blooded.

In the former diviſion there is always an interior ſkeleton; a ſpinal marrow contained in the vertebral canal; never more than four members, of which one, or both pairs are wanting in ſome inſtances. The brain is contained in a cranium: there is a great ſympathetic nerve; five ſenſes; two moveable eyes; and three ſemicircular canals in the ear. The circulation is performed by one muſcular ventricle at leaſt. There are lymphatic, as well as blood veſſels. The jaws being placed horizontally, the mouth is opened by their moving from above downwards, or from before backwards. There is a continuous alimentary canal: peritoneum; liver, ſpleen, and pancreas, two kidneys, and renal capſules; and two teſticles.

The *vertebral* animals are ſubdivided into the warm and cold-blooded.

Warm blooded vertebral animals have been ventricles, and a double circulation; and breathe by means of lungs. The cranium is completely filled by the brain. The eyes are cloſed by eyelids. The tympanum of the ear is hollowed out of the cranium, and the labyrinth is excavated in the bone. Beſides the ſemi-circular canals, there is a cochlea. The noſtrils communicate with the fauces, and allow the paſſage of air into the lungs. The trunk is conſtantly furniſhed with ribs.

In *cold-blooded vertebral animals* the brain never entirely fills the cranium. The eyes ſeldom poſſeſs moveable eyelids. When the tympanum exiſts, it is on a level with the ſurface of the head. There is no cochlea. The different parts of the ear are connected but looſely to the cranium.

The diviſion of warm-blooded animals contains two claſſes; MAMMALIA and BIRDS.

The *mammalia* are viviparous, and ſuckle their young (from which circumſtance the name is derived). They

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[1] The *ornithorhynchus* is an exception to this rule; as it poſſeſſes only two oſſicula; and according to our author, other animals only poſſeſs three; as the *os lenticulare* is repreſented by him as an apophys of the *incus*.

have an uterus with two cornua; and the male has a penis.

There are two occipital condyles: a very complicated brain; four oſſicula auditus, and a ſpiral cochlea. The ſkin covered with hair. A muſcular diaphragm ſeparates the cheſt and abdomen. There is an epiglottis. The lower jaw only moves. The fluid in the lacteals is white, and paſſes through ſeveral conglobate glands. There is an omentum.

Blumenbach eſtabliſhes the following orders in this claſs:

I. Bimanum. Two handed.
Genus 1. *Homo.*

II. Quadrumana, four handed animals: having a ſeparate thumb, capable of being oppoſed to the other fingers, both in their upper and lower extremities. Teeth like thoſe of man, except that the *cuſpidati* are generally longer.
1. *Simiæ*, apes, monkeys, baboons.
2. *Lemur*, macauco.

III. Bradypoda, ſlow-moving animals.
1. *Bradypus*, ſloth.
2. *Myrmecophaga*, ant-eater.
3. *Manis*, ſcaly-lizard, or pangolin.
4. *Daſypus* or *Tatu*, armadillo.

This order forms two in the arrangement of Cuvier. 1ſt, Tardigrada; which includes the ſloths. There are no inciſors in either jaw. There is a complicated ſtomach, but no rumination. 2ndly, Edentata, toothleſs animals. Some of theſe have no teeth; others want the inciſores and cuſpidati. The tongue is long, ſlender, and projectile, for ſeizing the inſects on which the animals feed; body covered with hard ſubſtances. The armadillo, manis, ant-eater, and *ornithorhyncus*, or duck-billed animal belong to this order.

IV. Cheiroptera, having the fingers elongated for the expanſion of a membrane, which acts as a wing.
Veſpertilio, bat.

V. Glires. *Rodentia* of Cuvier—gnawing animals. Have two long and very large inciſor teeth in each jaw, by which they cut and gnaw hard bodies, chiefly vegetables. There is a large interval behind theſe teeth, unoccupied by cuſpidati.

1. *Sciurus*, ſquirrel.
2. *Glis*, dormouſe (*Myoxus Linn*).
3. *Mus*, mouſe and rat.
4. *Marmota*, marmot.
5. *Cavia*, guinea-pig.
6. *Lepus*, hare and rabbit.
7. *Jaculus*, jerboa.
8. *Caſtor*, beaver.
9. *Hyſtrix*, porcupine.

VI. Feræ, predaceous and carnivorous animals. Very ſtrong and large pointed canine teeth: molares forming pointed prominences. Short and ſimple alimentary canal, and conſequently ſlender belly.

1. *Erinaceus*, hedge-hog.
2. *Sorex*, ſhrew.
3. *Talpa*, mole.
4. *Meles*, badger.
5. *Urſus*, bear.
6. *Didelphis*, opoſſum, kanguroo.
7. *Viverra*, weaſels, ferret, polecat, civet.
8. *Muſtela*, ſkunk, ſtoat, &c.
9. *Canis*, dog, wolf, jackal, fox, hyena.

10. *Felis*, cat, lion, tiger, leopard, lynx, panther, &c.
11. *Lutra*, otter.
12. *Phoca*, ſeal or ſea-calf.

The five firſt genera of this order, form the *plantigrada* of Cuvier; animals which reſt the whole of the foot on the ground. They are leſs carnivorous than the others; have a longer inteſtinal canal, and no cæcum.

The ſixth genus forms the Pedimana of the ſame zoologiſt: as they poſſeſs a ſeparate thumb on the hind extremities only. They have a pouch in the abdomen containing the mammæ, and holding the young in their early ſtate. One ſpecies, the kanguroo, (*didelphis gigantea*), muſt however be excepted. That is placed among the *rodentia;* and does not poſſeſs the ſeparate thumb.

The order *carnivora* of Cuvier, will include from the 7th to the 11th genus: both incluſive. The ſeal belongs to his *amphibia*.

VII. Solidungula (*ſolipeda*, Cuvier), a ſingle toe on each foot, with an undivided hoof. Large inteſtines, and particularly an enormous cæcum. Inciſors in both jaws.

1. *Equus*, horſe and aſs.

VIII. Pecora or Bisulca (*Ruminantia* of Cuvier), a divided hoof. No inciſores in the upper jaw. Stomach conſiſting of four cavities. Rumination of the food. Long inteſtines.

1. *Camelus*, camel, dromedary, lama.
2. *Capra*, ſheep, goat.
3. *Antilope*, antelope, chamois.
4. *Bos*, ox, buffalo.
5. *Giraffa*, giraffe or camelopard.
6. *Cervus*, elk, deer-kind.
7. *Moſchus*, muſk.

IX. Belluæ, animals of an unſhapely form, and a tough and thick hide; whence they have been called by Cuvier, *pachydermata* (from παχυς thick, and δερμα ſkin). They have more than two toes: inciſors in both jaws; and in ſome caſes enormous tuſks.

1. *Sus*, pig kind, pecari, babirouſſa.
2. *Tapir*,
3. *Elephas*,
4. *Rhinoceros*,
5. *Hippopotamus*,
6. *Trichecus*, morſe or walrus, manati or ſea-cow.

The laſt genus of this order, together with the *phoca* (ſeals) conſtitutes the *Amphibia* of Cuvier. Theſe animals have ſhort members adapted for ſwimming.

X. Cetacea, whales, living entirely in the ſea; and formed like fiſhes; breathe by an opening at the top of the head, called the *blowing-hole;* through which they throw out the water, which enters their mouth with the food. Smooth ſkin covering a thick layer of oily fat. No external ear. A complicated ſtomach. Multilobular kidneys, larynx of a pyramidal ſhape, opening towards the blowing-hole. Teſtes within the abdomen. Mammæ at the ſides of the vulva. Bones of the anterior extremity concealed and united by the ſkin, ſo as to form a kind of fin.

1. *Monodon*, narwhal, ſea-unicorn.
2. *Balæna*, proper whales.
3. *Phyſeter*,
4. *Delphinus*, dolphin, porpoiſe.

Cuvier diſtributes the claſs *mammalia* into three grand diviſions:

1. Thoſe which have claws or nails (*mammiféres a ongles*); including the following orders:

bimana, quadrumana, cheiroptera, plantigrada, carnivora, pedimana, rodentia, edentata, tardigrada.

2. Thoſe which have hoofs (*mammif. a ongles*) including the pachydermata, ruminantia and ſolipeda.
3. Thoſe which have extremities adapted for ſwimming (*mammif. a pieds en nageoire*). Amphibia and cetacea.

Birds are oviparous; have a ſingle ovary and oviduct; a ſingle occipital condyle; a very large ſternum; and anterior extremities adapted for flying.

They have three eyelids; no external ear; a cochlea conical, but not ſpiral; a ſingle oſſiculum auditus; body covered with feathers. The lungs are attached to the ſurface of the cheſt; and penetrated by the air, which goes all over the body: there is a larynx at each end of the trachea; no epiglottis. The jaws are covered with a horny ſubſtance. The chyle is tranſparent; no meſenteric glands; nor omentum. No bladder of urine; the ureters terminating in a bag through which the eggs and fæces come, viz. the cloaca.

This claſs cannot be diſtributed into orders ſo clearly diſtinguiſhed by anatomical characters as the preceding one. Blumenbach divides them into two leading diviſions.

(A) Terrestrial Birds.

Order I. Accipitres. Birds of prey; with ſtrong hooked bills, and large curved talons, a membranous ſtomach, and ſhort cæca.

1. *Vultur*, vultures.
2. *Falco*, falcon, eagle, hawk, kite.
3. *Strix*, owl.
4. *Lanius*, ſhrike or butcher bird.

II. Levirostres, light billed birds, having a large hollow bill.

1. *Pſittacus*, parrot kind.
2. *Ramphaſtos*, toncan.
3. *Buceros*, rhinoceros bird.

III. Picæ, this and the two following orders are no clearly charaćteriſed.

1. *Picus*, woodpecker.
2. *Jynx*, wryneck.
3. *Sitta*, nuthatch.
4. *Alcedo*, kingsfiſher.
5. *Trochilus*, humming birds, &c. &c.

IV. Coraces.

1. *Corvus*, crow, raven, jackdaw, magpie, jay, &c.
2. *Coracias*, roller.
3. *Paradiſea*, birds of paradiſe,
4. *Cuculus*, cuckow, &c. &c.

V. Passeres, ſmall ſinging-birds.

1. *Alauda*, lark.
2. *Sturnus*, ſtarling.
3. *Turdus*, thruſh, blackbird.
4. *Emberiza*, bunting.
5. *Fringilla*, finches, canary-bird, linnet, ſparrow.
6. *Motacilla*, nightingale, redbreaſt, wren.
7. *Hirundo*, ſwallows, martins, &c.
8. *Caprimulgus*, goatſucker. &c.

VI. GALLINÆ, gallinaceous birds, moſtly domeſticated. They poſſeſs a large crop, ſtrong muſcular g

1. *Columba*, pigeons.
2. *Tetrao*, grous, quail, partridge
3. *Numida*, guinea-fowl.
4. *Meleagris*, turkey.
5. *Pavo*, peacock.
6. *Otis*, buſtard.

VII. STRUTHIONES, ſtruthious birds. The largeſt of the claſs: poſſeſs extremely ſmall wings, and are therefore incapable of flight; but run very ſwiftly.

1. *Struthio*, oſtrich.
2. *Caſuarius*, caſſowary or emu.

(B) AQUATIC BIRDS.

Order I. GRALLÆ, waders, frequenting marſhes and ſtreams; long naked legs; long neck; cylindrical bill of different lengths.

1. *Ardea*, crane, ſtork, heron, bittern.
2. *Scolopax*, woodcock, ſnipe, curlew.
3. *Tringa*, lapwing, ruffs and reeves.
4. *Charadrius*, plover.
5. *Fulica*, coot.
6. *Rallus*, rail.
7. *Phænicopterus*, flamingo.
8. *Tantalus*, ibis, &c.

II. ANSERES, ſwimming birds; web-footed; bill, broad and flat, covered by a ſomewhat ſoft ſubſtance, on which large nerves are diſtributed.

1. *Colymbus*, diver.
2. *Larus*, gull.
3. *Procellaria*, petrel,

4. *Diomedea*, albatroſs.
5. *Pelecanus*, pelican, cormorant.
6. *Anas*, ſwan, duck, gooſe.
7. *Mergus*, gooſander.
8. *Alca*, auk, puffin.
9. *Aptenodytes*, penguin.

The two claſſes of *cold-blooded vertebral animals* are the AMPHIBIA and FISHES.

The former, differing conſiderably from each other, have very few common characters; for in different inſtances they walk, fly, ſwim, and crawl. There is no external ear, nor cochlea; the brain is always very ſmall. The lungs are in the ſame cavity with the other viſcera; no epiglottis, omentum, nor meſenteric glands. Two ovaries and oviducts. Cloaca, through which the fæces and urine are expelled; and in which the organs of generation terminate. Neither hair, feathers, nor mammæ.

Order I. REPTILIA, having four feet, (*quadrupeda ovipara*).

1. *Teſtudo*, tortoiſe, turtle.
2. *Rana*, frog, toad.
3. *Lacerta*, lizards, crocodile, chameleon, newt, ſalamander, iguana, &c.

II. SERPENTIA. No external members; body of an elongated form, and viſcera of a ſimilar ſhape. They are oviparous; but the egg is ſometimes hatched in the oviduct. Both jaws moveable.

1. *Crotalus*, rattleſnake.
2. *Boa*. Immenſe ſerpents of India and Africa.
3. *Coluber*, viper.
4. *Anguis*, blindworm.

5. *Amphiſbæna.*
6. *Cæcilia.*

Fishes. Breathe by means of branchiæ or gills; and have no trachea, nor larynx. Organs of motion conſiſting of fins. Noſe unconnected with the organs of reſpiration. Ear entirely incloſed in the head; the tympanum, &c. being abſent Both jaws moveable. The place of the pancreas ſupplied by the pyloric cæca. An urinary bladder. Two ovaries. Heart conſiſting of a ſingle auricle and ventricle. They may be diſtributed into two leading diviſions; the *cartilaginous*; whoſe ſkeleton conſiſts of cartilage: the *bony*; where it is formed of a more firm ſubſtance.

(A) Cartilaginous Fishes.

Order I. Chondropterygii; having no gill-cover; an uterus, with two oviducts.

1. *Petromyzon*, lamprey.
2. *Gaſtrobranchus.*
3. *Raia*, ſkate, torpedo, ſtingray.
4. *Squalus*, ſhark, ſaw-fiſh.
5. *Lophius*, ſea-devil, frog-fiſh.
6. *Baliſtes*, file-fiſh.
7. *Chimæra.*

II. Branchiostegi; having a gill-cover.

1. *Accipenſer*, ſturgeon, beluga.
2. *Oſtracion*, trunk-fiſh.
3. *Tetrodon.*
4. *Diodon*, porcupine-fiſh.
5. *Cyclopterus*, lumpſucker.
6. *Centriſcus.*
7. *Syngnathus*, pipe-fiſh.
8. *Pegaſus.*

(B) **Bony Fishes**, divided according to the ſituation of their fins.

Order I. Apodes; no ventral fins.

1. *Muræna*, eel-kind.
2. *Gymnotus*, electrical eel.
3. *Anarrhichas*, ſea-wolf.
4. *Xiphias*, ſword-fiſh.
5. *Ammodites*, launce.
6. *Ophidium.*
7. *Stromateus.*
8. *Trichiurus.*

II. Thoracici; ventral fins directly under the thoracic.

1. *Echeneis*, ſucking fiſh,
2. *Coryphæna*, dorado.
3. *Zëus*, dory.
4. *Pleuronectes*, flounder, plaice, dab, holibut, ſole, turbot.
5. *Chæladon.*
6. *Sparus.*
7. *Perca*, perch.
8. *Scomber*, mackarel, bonito, tunny.
9. *Mullus*, mullet.

&c. &c.

III. Abdominales; ventral fins behind the thoracic; chiefly inhabit freſh water.

1. *Cobitis*, loach.
2. *Silurus.*
3. *Salmo*, ſalmon, trout, ſmelt.
4. *Eſox*, pike.
5. *Clupea*, herring, ſprat, ſhad.
6. *Cyprinus*, carp, tench, gold-fiſh, minow, &c.

&c.

IV. JUGULARES; ventral fins in front of the thoracic.

1. *Gadus*, hadock, cod, whiting, ling.
2. *Uranoſcopus*, ſtargazer.
3. *Blennius*, blenny.
4. *Callionymus*, dragonet.
5. *Trachinus*, weaver.

The animals which have no vertebral column, do not poſſeſs ſo many common characters as the vertebral claſſes. Their hard parts, when they have any, are generally placed on the ſurface of the body. The centre of the nervous ſyſtem, inſtead of being incloſed in a bony caſe, lies in the ſame cavity with the viſcera. The œſophagus is generally ſurrounded by a nervous chord coming from the brain. Their reſpiration is not carried on by lungs; and they have no voice. Their jaws move in various directions. They have no urinary ſecretion.

The *invertebral animals* were diſtributed by LINNEUS into two claſſes; *inſects* and *worms (vermes)*. The anatomical ſtructure of theſe animals was very imperfectly known, when the Swediſh naturaliſt firſt promulgated his arrangement. But the labours of ſubſequent zoologiſts, and particularly thoſe of CUVIER, have ſucceeded in eſtabliſhing ſuch ſtriking and important differences in their formation, that a ſubdiviſion of the Linnean claſſes became indiſpenſibly neceſſary. The inſects of LINNEUS are divided into *cruſtacea* and *inſecta*: and the *vermes* of the ſame author form three claſſes; viz. *molluſca*, *vermes*, and *zoophyta*.

The *molluſca* derive their name from the ſoft fleſhy nature of their body. This claſs includes thoſe pulpy animals, which may either be deſtitute of an external covering; when they are called *molluſca nuda*; as the ſlug: or may be encloſed in one or more ſhells, as the ſnail, oyſter, &c. when they are termed *teſtacea*.

The animals of this claſs have no articulated members: they have blood-veſſels, and a true circulation. They reſpire by means of gills. They have a diſtinct brain, giving origin to nerves; and a ſpinal marrow.

1. *Sepia*, cuttlefiſh.
2. *Argonauta.*
3. *Nautilus.*
4. *Limax*, ſlug.
5. *Aplyſia.*
6. *Doris.*
7. *Clio.*
8. *Patella*, limpet.
9. *Helix*, ſnail.
10. *Haliotis*, Venus's ear.
11. *Murex*, caltrop, or rockſhell.
12. *Strombus*, ſcrew.
13. *Buccinum*, whelk.
14. *Aſcidia.*
15. *Thalia.*
16. *Oſtrea*, oyſter.
17. *Solen*, razorſhell.
18. *Cardium*, cockle.
19. *Mytilus*, muſcle.

&c. &c.

Cuvier claſſes the numerous genera of this order under the three following diviſions; 1ſt, *cephalopoda*, (from κεφαλη the head, and πȣς the foot) which have their organs of motion placed round the head: 2dly, *gaſteropoda*, (from γαϛηρ the belly, and πȣς), ſuch as crawl on the belly: and 3dly, *acephala*, (from α privative, and κεφαλη), which have no head. The three firſt genera belong to the firſt diviſion; the ten ſucceeding ones come under the ſecond; and the remainder exemplify the laſt order.

According as the ſhell of the *teſtaceous molluſca* conſiſts of a ſingle convoluted tube; or of two or more ſeparate pieces, they are called *cochleæ bivalves, multivalves*, &c.

Crustacea poſſeſs a hard external covering, and numerous articulated members. A long nervous chord, beſet with ganglia. Compound eyes. Antennæ and palpi like thoſe of inſects. A heart and circulating veſſels; and gills. Teeth in the cavity of the ſtomach.

1. *Cancer*, crab, lobſter, crayfiſh, ſhrimp.
2. *Monoculus*.

Insects have articulated members and antennæ. Thoſe which fly are ſubject to what is called a *metamorphoſis*: they paſs through certain intermediate ſtates of exiſtence, before they aſſume the laſt, or perfect form. From the egg proceeds the *larva*, or catterpillar: this changes to the *chryſalis, nympha*, or *aurelia*; from which the perfect inſect is produced. Nervous ſyſtem conſiſting of a chord beſet with ganglia. No heart nor blood-veſſels. Reſpiration carried on by means of tracheæ.

Order I. Coleoptera; having a hollow horny caſe, under which the wings are folded.

1. *Scarabæus*, beetles.
2. *Lucanus*, ſtag-beetle.
3. *Dermeſtes*.
4. *Coccinella*, ladybird.
5. *Curculio*, weevil.
6. *Lampyris*, glow-worm.
7. *Meloe*, Spaniſh-fly.
8. *Staphylinus*.
9. *Forficula*, earwig.

II. HEMIPTERA; four wings, either ſtretched ſtraight out, or reſting acroſs each other.

1. *Blatta*, cockroach.
2. *Gryllus*, locuſt, graſshopper.
3. *Fulgora*, lantern-fly.
4. *Cimex*, bug.

&c. &c.

III. LEPIDOPTERA; ſoft hairy body, and four expanded wings.

1. *Papilio*, butterfly.
2. *Sphinx*, } moths.
3. *Phalæna*, } moths.

IV. NEUROPTERA; four reticulated wings.

1. *Libellula*, dragon-fly.
2. *Ephemera*.

&c.

V. HYMENOPTERA; generally poſſeſſing a ſting.

1. *Veſpa*, waſp, hornet.
2. *Apis*, bee.
3. *Formica*, ant.
4. *Termes*, white ant.
5. *Ichneumon*.

&c.

VI. DIPTERA; two wings.

1. *Œſtrus*, gad-fly.
2. *Muſca*, common flies.
3. *Culex*, gnat, moſquito.
4. *Hippoboſca*, horſe-leech.

&c.

VII. APTERA; no wings.

1. *Podura*, ſpringtail.
2. *Pediculus*, louſe.
3. *Pulex*, flea, chigger.
4. *Acarus*, tick, mite.
5. *Aranea*, ſpiders.
6. *Scorpio*, ſcorpion.

&c.

The VERMES may be divided into two orders; the *inteſtinal*, which inhabit the bodies of other animals; and the external.

The former are not of ſuch a complicated organiſation as the latter; ſo that they are ſometimes arranged among the zoophytes. The external worms have a nervous chord poſſeſſing ganglia, an elongated body compoſed of rings; and having no diſtinct head. There are no members. Circulating veſſels, but no heart. No nerves have been diſcovered in the inteſtinal worms.

Order I. INTESTINI.

1. *Gordius*, guinea-worm.
2. *Aſcaris*, thread-worm, round-worm.
3. *Tricocephalus*.
4. *Faſciola*, fluke.
5. *Tænia*, tape-worm.
6. *Hydatis*, hydatid.

II. EXTERNI.

1. *Aphrodite*, ſea-mouſe.
2. *Sipunculus*.
3. *Hirudo*, leech.
4. *Nereis*.
5. *Nais*.
6. *Planaria*.
7. *Lumbricus*, earthworm.

&c.

The ZOOPHYTES have neither brain nor nerves; no heart, nor, perhaps, blood-veſſels; no articulated members.

Order I. ECHINODERMATA; covered by a hard and tough coriaceous ſkin.

1. *Echinus*, ſea hedgehog.
2. *Aſterias*, ſtar-fiſh.
&c.

II. SOFT OF GELATINOUS ZOOPHYTES.

1. *Meduſa*, ſea-blubber, ſea-nettles.
2. *Actinia*, ſea-anemone.
3. *Hydra*, freſh water polype.

III. INFUSORIA, the animalcules of infuſions.

1. *Vorticella*, wheel-animal.
2. *Brachionus*.
3. *Vibrio*, eel of vinegar.
4. *Volvox*.
6. *Monas*.

IV. Inhabitants of corals, corallines, ſponges, &c.

Lately publiſhed, by the ſame Author,

A Deſcription of the Arteries, arranged in the Form of Tables, for the Uſe of Students; tranſlated from the Latin of A. Murray, Profeſſor of Anatomy at Upſal.

COMPARATIVE OSTEOLOGY.

CHAPTER I.

ON THE BONES OF ANIMALS IN GENERAL.

§ 1. RED-BLOODED[1] animals only poſſeſs a true *ſkeleton;* to which all their bones[2] are connected, and on which the general form[3], as well as the greater or leſs flexibility of the body depend.

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[1] Parts of a really bony ſtructure are found only in a few inſects and worms: viz. in the ſtomach of the lobſter, and other ſpecies of the genus *cancer;* in the mouth of the ſea hedgehog (*echinus*), &c. Theſe parts at leaſt reſemble true bones more than that body, which is commonly called *cuttle-fiſh bone;* for the deſcription of which ſee note (A) at the end of the chapter.

[2] There are a few exceptions to the general rule, that "*all the bones of an animal enter into the formation of its ſkeleton:*" viz. the bone of the tongue, commonly called *os hyoides;* the bone of the penis, of ſeveral mammalia; the bony ring in the ſclerotica of birds; the *clavicular bones* of ſome mammalia, &c.

(To theſe inſtances we muſt add two others, which, though not enumerated by the author, are ſufficiently remarkable to deſerve notice: viz. the whole anterior extremity in ſuch mammalia, as poſſeſs no clavicles; and the abdorminal fins of fiſhes, which correſpond to the poſterior extremities of other animals.) T.

[3] See Galen's remarks on this ſubject, when ſpeaking of the reſemblance between the ape and the human ſubject; in the 1ſt book of his Chef-d'œuvre *de Anatomicis Adminiſtrationibus,* tom. 4. p. 26. Chartier's edition.

§ 2. The ordinary white [4] colour of the bones has ſeveral gradations, which are ſometimes obſervable in the different parts of the ſame bone; as in the grinding teeth of the elephant *, And, in ſome few genera the whole bony ſtructure is of a different colour [5]. Thus, in the garpike, (*eſox belone*) the bones are green; and in ſome varieties of the common fowl they approach to a black colour [6].

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[4] The red tint, which the bones of animals receive in conſequence of madder being mixed with the food, is obſerved by ANT. MISAUD, in his *Centuriæ Memorabilium ſeu Arcanorum omnis generis*, p. 161. Cologne, 1572. 12mo.

It is remarkable, that this well known experiment meets with very imperfect ſucceſs in cold blooded animals.

* A ſection of a grinding tooth of the elephant, or of any other herbivorous animal, as the horſe, ox, &c. ſhews that its ſubſtance contains parts differing conſiderably in appearance. Beſides the proceſſes of enamel, which are intermingled throughout with the bone, there are two kinds of oſſeous ſtructure of different colours. In the above remark, the author probably alludes to this circumſtance, although he has not particularly deſcribed this formation in that part of his work, which treats on the teeth. See the additional obſervations on that ſubject at the end of the Chapter. T.

[5] This has however been aſſerted without foundation of ſome animals: thus NICHOLLS, in his *Compend. Anat.* p. 7, ſays that the *amedabad finch (fringilla amandava)* has yellow bones; and others have ſtated the ſame circumſtance reſpecting the *golden pheaſant, (phaſianus pictus)*. I have diſſected both theſe animals, and found the aſſertions to be incorrect.

§ 3. The ſtructure of the bones is ſubject to ſtill greater variations; which occur in the different bones of the ſame ſkeleton, as well as in the whole ſkeleton of particular claſſes and orders. Inſtances may be obſerved in the dry and brittle texture of the air bones of birds; in the long fibres, which appear on ſplitting the bones of the larger amphibia and fiſhes; in the peculiar tenacity and ſolidity of individual parts in ſome cartilaginous fiſhes *.

§ 4. Excepting the crown of the teeth, bones are univerſally covered with perioſteum; and for the moſt part they contain marrow [7] internally;

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[6] ABULFAZEL, the vizier of AKBER the Great, has remarked this of the fowls at Indore, and Neermul in Berar; in his claſſical work *Ayeen Akbery*, vol. 2. p. 72. and Niebuhr has ſtated it of thoſe at Perſepolis. Travels, vol. 2.

(Mr. Hunter is ſaid to have diſcovered that the blackneſs reſides in the perioſteum. *Rees's Cyclopædia*, Art. BIRDS.) T.

* For a further account of the differences in the ſtructure of bones ſee note (A) at the end of the chapter.

[7] The erroneous opinion, which ARISTOTLE held, of the want of marrow in the bones of the lion, does not require an expreſs refutation. On that ſubject, as well as on ſome other miſtaken aſſertions, ſee R. HENER *apolog. pro* VESALIO *adverſus* SYLVIUM. Venet. 1555. 8vo. p. 27.

which

which varies much in conſiſtence, being fluid in the whales.

§ 5. Bones are formed by the oſſification of original cartilages; the teeth being again for the moſt part excepted. Oſſification commences earlier and proceeds more rapidly in viviparous, than in oviparous animals[8]. This fact appears at leaſt from comparing the incubated bird with the fœtus of mammalia. Again, in the latter claſs, many points in the formation of the bones are completed ſooner in quadrupeds than in man *[9].

Additional

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[8] It is well known that the incubation of the chick occupies twenty-one days. The commencement of oſſification is not perceptible before the beginning of the ninth day; which correſponds with the ſeventeenth week of human pregnancy. In the human embryo the firſt points of oſſification may be diſcerned in the ſeventh or eight week after conception, (certainly not in the third or fourth week, as ſome great anatomiſts have lately ſuppoſed). Theſe facts ſhew how little confidence can be placed in that remark of HALLER's, which concludes his excellent obſervations on the formation of the bones in the incubated chick. "The facts, which we have ſhewn in the bones of the chick, will hold good of thoſe of the other claſſes of animals, and of man."

* In note (B) at the end of the chapter, there is a ſhort account of the compoſition of the different bony ſubſtances, which belong to the various claſſes of animals. T.

[9] An example occurs in the cloſure of the fontanells. I have found theſe openings of conſiderable ſize in young fœtuſes of the *feræ* and *pecora*, but could hardly diſcern any trace

Additional Notes on the Firſt Chapter.

(A) Oſſification does not go on with equal rapidity in all animals, nor in all the bones of the ſame animal. Thus the oſſification of the internal ear of man, and the mammalia, is completed before any other parts; and it ſurpaſſes all other bone in its denſity, and in the proportional quantity of phoſphate of lime, which it contains. In the *cetacea*, particularly the *balæna* and *phyſeter* (the black and white whales,) this part acquires a denſity and hardneſs equal to that of marble. Its ſection preſents an homogeneous appearance, without the leaſt veſtige of fibres, cellular texture, or veſſels.

Bones are ſlow in acquiring their complete formation, in proportion to the remoteneſs of the period, at which the growth of the animal is finiſhed. The ſkeleton remains conſtantly in a cartilaginous ſtate in ſome animals; ſuch are the *ſhark*, *ſkate*, *ſturgeon*, and all thoſe fiſhes, which,

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trace of them at the time of birth; nothing at leaſt which could be compared to their magnitude in a human fœtus of nine months. When we compare the pelvis, and the whole mechaniſm of parturition in the woman, with thoſe of the female quadruped, the cauſe of this difference appears. We then diſcover, why the yielding and overlapping of the large bones of the cranium, which is chiefly effected by the fontanells, is only required to facilitate the birth of the human fœtus.

from this circumſtance, have been denominated cartilaginous, or *chondropterygii.* Although the bones of other fiſhes, of reptiles, and ſerpents acquire a greater hardneſs, they conſtantly remain more flexible, and retain a larger proportion of gelatine in their ſtructure, than thoſe of warm-blooded animals.

The bony texture of the mammalia is not ſo fine and delicate as that of man: it is particularly looſe and coarſe in the *cetacea*, where the diſtinction of the fibres is very manifeſt, even on the external ſurface. In the jaw and the ribs particularly, they may be looſened by maceration, and become very obvious.

The bones of reptiles and fiſhes have a very homogeneous appearance, the earthy matter and the gelatine appearing to be uniformly mingled; this is more ſtrikingly marked, as we approach to the cartilaginous fiſhes, where the gelatine predominates, and conceals the earth.

Several animals have no medullary cavities even in their long bones. This is the caſe with the *cetacea*, the *ſeal*, and *turtle.*

The ſtructure of the bones of birds ſhould be noticed in this place. They are almoſt univerſally hollow: but their cavities, which never contain marrow, are filled with air. This organization unites the advantages of lightneſs and ſtrength. For a further account of it ſee the chapter on the organs of reſpiration.

The *horn* of the ſtag is a real bone, as appears both from its texture, and its component elements. Its outer part is hard, compact, and fibrous: the internal ſubſtance is reticulated, but very firm; and poſſeſſes no cavities nor marrow. See the chapter on the *ſkeleton of the mammalia*, for the mode of its formation, &c.

The ſhells of the teſtaceous animals are formed of a calcareous ſubſtance, which is ſometimes laminated; ſometimes as hard and denſe as marble. This is mingled, as in other bones, with a gelatinous matter, from which it may be ſeparated by means of acids. The earth is not diſpoſed in fibres or laminæ, as in other bones; but is uniformly expanded through the animal ſubſtance.

The layers of the ſhell are formed ſucceſſively, as the animal increaſes in ſize. The exterior or ſmalleſt are formed firſt: others are ſucceſſively depoſited on the inner ſurface of theſe; each new layer extending beyond the margin of the former one, ſo that the ſhell, by every addition increaſes in thickneſs and circumference. Are theſe new layers formed by veſſels exiſting in the ſhell itſelf, or are they produced by exudation from the ſurface of the animal? REAUMEUR broke the ſhell of ſnails, and found that no reproduction took place, when he covered the expoſed part of the animal's body; while the injury was quickly repaired, when no artificial obſtacle impeded the effuſion of fluids from the ſurface. This experiment seems to prove that the ſhell is formed by depoſition from the body of the animal: but there is an argument equally ſtrong in favour of the exiſtence of veſſels in the ſhell itſelf. Between the two laſt formed layers of the convex ſhell of the oyſter, a conſiderable cavity is found, filled with a fluid, and communicating by a particular opening with the internal parts of the body. This muſt be deſtroyed and reproduced whenever a new lamina is added; and we cannot underſtand how ſuch proceſſes can be effected without arterial and abſorbing veſſels.

Cruſtaceous animals, (crab, lobſter, &c.) have a ſkeleton which ſurrounds and contains their ſoft parts, and which ſerves at the ſame time the purpoſes of a ſkin. When it has attained its perfect conſiſtence, it grows no more: but as the ſoft parts ſtill increaſe, the ſhell ſeparates, and is detached, being ſucceeded by a larger one. This new covering is partly formed before the other ſeparates: it is at firſt ſoft, ſenſible, and vaſcular; but it ſpeedily acquires a hard conſiſtence by the increaſed depoſition of calcareous matter.

Some of the *molluſca* have hard parts in the interior of their body. The common cuttlefiſh *(ſepia officinalis)* has a white, firm, and calcareous maſs of an oval form, and ſlightly convex on its two ſurfaces, commonly known by the name of the *cuttlefiſh-bone*, contained in the ſubſtance of its body. It has no connection with any ſoft part, whence it appears completely as a foreign body: no veſſel nor nerve can be perceived to enter it; nor does it receive the attachment of any tendon. In the calmar *(ſepia loligo)*, this body reſembles horn in its appearance; it is tranſparent, hard, and brittle. Its form reſembles that of a leaf, except that it is larger; and ſometimes that of a ſword-blade. Theſe parts muſt grow like ſhells, by the ſimple addition of ſucceſſive layers.

(B). As chemical analyſis has diſcovered ſome intereſting differences in the conſtituent ingredients of the hard parts of various animals; it ſeems right to give a ſhort account of them in the preſent place.

The bones and teeth of red-blooded animals, conſiſt chiefly of phoſphate of lime, depoſited in the interſtices of an animal ſubſtance; which, when freed from the earthy matter by the immerſion of the bone in an acid, approaches in its conſiſtence to cartilage. This is completely diſſolved by boiling in a cloſe veſſel, and is thereby proved to conſiſt of gelatine. A ſmall quantity of carbonate of lime is mixed with the phoſphate; and hence effervescence ariſes when a bone or tooth is ſubjected to the action of acids.

The relative proportions of theſe ingredients in the general ſtructure of bone have not hitherto been determined with much accuracy; but the obvious differences of ſtructure and appearance not only in the different claſſes, orders, and genera, but even in the ſeveral bones of the ſame individual, and in parts of the ſame bone, leave no doubt that much variation muſt exiſt in theſe points.

The horn of the ſtag is bone, containing a large proportion of gelatine.

The bones of fiſhes contain phoſphate of lime; but the animal ſubſtance exiſts in very large proportion, particularly in thoſe which are called cartilaginous, where it completely obſcures the earthy matter.

Carbonate and phoſphate of lime, depoſited on a cartilaginous baſis, which retains the form of the part, after the earthy matter has been ſeparated, conſtitute the external covering of the cruſtaceous animals (crab, lobſter, &c.). The carbonate is in greateſt quantity.

Carbonate of lime, with a ſmall quantity of phoſphate, forms the earthy principle of the ſhell of the echinus.

The ſhells of the teſtacea, are entirely compoſed of carbonate of lime, united to a gelatinous ſubſtance. When immerſed in acid, a rapid efferveſcence enſues. Some of them, which are very hard in their texture, and have an enamelled ſurface, contain ſo little animal matter, that it does not retain the form of the ſhell, which is completely diſſolved by acids, like the enamel of the teeth. But others, which conſiſt of what is called mother of pearl, and are formed by ſucceſſive ſtrata, (e. g.

the oyſter, muſcle, &c.) contain a much larger proportion. When theſe have been macerated in acid, a gelatinous ſubſtance remains, conſiſting of ſeveral layers of membrane, arranged ſtratum ſuper ſtratum.

It appears therefore, that *phoſphate of lime* is the peculiar earth of *bone*, and *carbonate* that of *ſhell;* although no bone has been hitherto diſcovered, without a ſmall admixture of the latter ingredient. Hence that ſingular production from the body of the cuttle-fiſh is improperly called bone; as it conſiſts, like ſhells, of various membranes, hardened by carbonate of lime, without any phoſphate. See "*Experiments and Obſervations on Shell and Bone,*" by C. HATCHETT, Eſq. *Philoſ. Tranſ.* 1799.

The ſame excellent chymiſt has alſo found, that the *zoophytes*, conſiſt of carbonate of lime joined in different inſtances to various proportions of animal ſubſtance. *Philoſ. Tranſ.* 1800, part 2.

CHAPTER II.

ON THE SKELETON OF MAMMALIA.

§ 6. THE form of the different mammalia, particularly the fourfooted ones, varies conſiderably; and their ſkeletons muſt be marked by correſponding differences. Yet theſe varieties may be included, at leaſt for the greateſt part, under the following peculiarities; which ſerve to diſtinguiſh their ſkeletons from thoſe of birds.

The ſkeletons of mammalia poſſeſs ;	Thoſe of birds are diſtinguiſhed by ;
1. A ſkull with genuine ſutures, (at leaſt with very few exceptions; as perhaps the *elephant*, and the duck-billed animal[1], *ornithorhyncus*).	1. * A ſkull which has not real ſutures[2].
2. Jaws furniſhed with teeth.	2. A bill without teeth.

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[1] This is the caſe, at leaſt, with my ſpecimen: the cranium, deſtitute of ſutures, conſiderably reſembles that of a bird in this point.

* See note (A) at the end of the chapter.

[2] This is meant to apply to adult birds; for young individuals have at leaſt ſeparate bones in their crania, if they are not connected by real denticulated ſutures.

Except

Except the *ant-eaters*, the *manis*, the duck-billed animal *, the *balæna* (whale).	
3. An upper jaw, which does not move.	3. An upper jaw, which does move. There are ſome exceptions, viz. the *rhinoceros bird.*
4. An *os intermaxillare.* (For the probable exceptions, ſee § 14.)	4. No *os intermaxillare.*
5. Two occipital condyles.	5. A ſingle occipital condyle.
6. Seven cervical vertebræ. Except the *three-toed ſloth*, and ſome *cetacea.*	6. More than ſeven cervical vertebræ.
7. Moveable dorſal vertebræ.	7. Motionleſs dorſal vertebræ.
8. A pelvis cloſed in front. Except the *ant-eaters*; which have it open: and the *cetacea*, which have none.	8. A pelvis open anteriorly. Except the *oſtrich.*

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* This exception is not ſtrictly correct; as the duck-billed animal has been found to poſſeſs a peculiar kind of horny teeth. See the additional note to § 30. T.

9. True

9. True clavicles in a few genera only.	9. Clavicles conſtantly: and almoſt as univerſally the *fork-like bone*.

§ 7. We ſhall firſt deſcribe the cranium of mammalia; ſince its ſtructure moſt materially influences the whole animal economy, from ſerving as a receptacle for the brain, the organs of ſenſe, and thoſe of maſtication.

§ 8. The well known diviſion of the bones of the head, into thoſe of the cranium, and of the face, is convenient for pointing out the remarkable proportions of relative magnitude in the two diviſions [3]. Compare, for inſtance, the ſkull of the *orang-outang (ſimia ſatyrus)* with that of the *mandril (papio maimon)*; or that of the porpoiſe, with the *white whale*.

§ 9. The number of proper bones of the cranium is, on the whole, the ſame as in the human ſubject. The os frontis in moſt of the *horned animals*, is compoſed of two equal portions: the two parietal bones are conſolidated into one in many of theſe, and in others they are united to the occiput. Some of the *glires* have a ſeparate piece between the parietal and occipital bones[4] *.

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[3] A profile view anſwers as well for this purpoſe as a view from above. I have explained the uſe of the latter, (which I call *norma verticalis*) in comparing the national forms of human crania, in the 3d edition of my work, *De Generis humani Varietate Nativa*, p. 203. and in the 4th, *Decas. Cran. divers. Gent.* p. 12.

§ 10. A principal variation in the form of the cranium, ariſes from the ſize and direction of the *criſta occipitalis* †, which bears a determinate proportion to the ſtrength of the jaws. It is wanting in the *orang-outang*; but is very large in the *baboon of Borneo.*[5]. *The longitudinal* criſta is very ſtrongly expreſſed in the *badger;* and the *tranſverſe ridge* is remarkable in the *beaver.* Between the arched ſides of the upper part of the cranium in the *elephant*, lies a broad and deep impreſſion, with a longitudinal criſta at its bottom.

There is conſiderable difference in this reſpect, between the different races of dogs: viz. between the pug-dog, and that of Newfoundland.

§ 11. The ſituation and direction of the *great occipital foramen* are attended with remarkable variations in ſome inſtances. Inſtead of lying horizontally, as in the human ſubject, (where indeed the anterior margin is ſometimes higher than the poſterior) it is placed in moſt quadrupeds at the extremity of the cranium, and obliquely, with the poſterior border turned upwards. In ſome, indeed, its direction is completely vertical; and in the *marmot of the Alps*, its upper margin is turned more forwards than the lower[6] *.

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[4] See MERREM's Anatomy of the Domeſtic Mouſe; in his *Miſcellaneous Obſervations on Natural Hiſtory:* and MEYER's *Prodromus Anat. Murium;* who calls it *os tranſverſum.*

* See note (B), at the end of the chapter.

† See note (C), at the end of the chapter.

[5] This completely untailed baboon, was firſt deſcribed by WURMB, (who very wrongly called it the great *orang-outang,* or *pongo)* in the 2d vol. of the *Tranſactions of the Batav. Society.* I ſaw a drawing of its monſtrous ſkeleton, which is four feet two inches high, at the cabinet of the Hague, in December 1791.

§ 12. The ſutures, which connect the individual bones of the cranium, are generally leſs intricate, at leaſt to outward appearance, in quadrupeds than in man. Their teeth are however ſtrong and ſharp in the *horned pecora*, for obvious reaſons; and the frontal bones are thick in the ſame animals [7]. *Oſſa triquetra* are ſeldom ſeen in the crania of animals. Yet I have ſpecimens of theſe, in the *hare* and *orang-outang;* the ſutures of the latter are remarkably elegant [8].

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[6] See DAUBENTON, on *the different Situation of the great Occipital Foramen in Man and Animals*, in the *Mem. de l'Acad. des Sc. de Paris*, 1764. On the difference, which we are now conſidering, this excellent zootomiſt founded his *occipital line*, which has been employed in the compariſon of different crania with each other. He draws two lines, which interſect each other in the profile of the ſkull: One paſſes from the poſterior margin of the *great foramen*, (which, in almoſt all mammalia, is alſo the ſuperior one,) through the lower edge of the orbit; the other takes the direction of the opening itſelf, beginning at its poſterior edge, and touching the articular ſurface of the condyles. He determines, according to the angle formed by the junction of theſe two lines, the ſimilarity or diverſity of the form of crania.

This angle is, however, but an imperfect criterion; for its variations are included between 80° and 90° in almoſt all quadrupeds, which differ very eſſentially in other points. And ſmall variations occur in the individuals of one and the ſame genus.

* See note (D), at the end of the chapter.

§ 13. The general form [9] of the cranium, is moſt materially influenced by the direction, and the

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[7] In ſheep affected with the ſtaggers, where the hydatid is large, and ſituated at the ſurface of the brain, I have found this part of the bone almoſt completely abſorbed; ſo that it yielded to preſſure, and appeared like a thin cartilaginous membrane.

[8] That obſervation, which EUSTACHIUS makes, concerning the ſutures of apes, muſt therefore be underſtood with ſome limitation; "they are always ſo obſcure, as ſcarcely ever to deſerve the name of ſutures." *Oſſium examen*, p. 173.

[9] To determine this with greater preciſion, CAMPER inſtituted the *facial line;* the application of which is moſt minutely explained in his poſthumous work, "*On the natural Differences of the Features*, &c." Like DAUBENTON, he draws on the profile of the cranium two ſtraight lines, which interſect each other; but in different directions from thoſe of the French anatomiſt. An *horizontal* line paſſes through the external auditory paſſage, and the bottom of the cavity of the noſe; this is interſected by a more *perpendicular* one, proceeding from the convexity of the forehead, to the moſt prominent point of the upper jaw, or of the intermaxillary bone. The latter is the proper *facial line;* and the angle, which it forms with the horizontal line, determines, according to Camper, the differences of the crania of animals, as well as the national phyſiognomy of the various races of mankind.

I have

the various degrees of prominence of the facial bones. The projection is generally formed by a prolongation of the upper jaw; partly alſo, and in many inſtances chiefly by the intermaxillary bone, which is incloſed between the two upper jaw bones *.

§ 14. The upper jaw-bones of other mammalia, do not, as in man, touch each other under the noſe, and contain all the upper teeth; but they are ſeparated by a peculiar, ſingle, or double *intermaxillary bone* [10], which is in a manner locked between the former, and holds the inciſor teeth [11] of ſuch animals, as are provided with theſe teeth. It exiſts alſo in the *pecora*, which have no inciſor teeth in the upper jaw; as well as in ſuch genera

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I have mentioned my objections to its application, in the latter point of view, in my work, *De Generis Humani Variet. Nativ.* 3d edit. p. 200. Concerning its uſe, as applied to the crania of animals, the ſame obſervations which were made on the line of Daubenton will hold good, mutatis mutandis. About three-fourths of all the ſpecies of quadrupeds, which we are hitherto acquainted with, whoſe crania differ extremely in other reſpects, have one and the ſame facial line.

* For a more particular account of the relative proportions of the cranium and face, together with the meaſure of theſe, according to the rules of Camper, ſee note (E), at the end of the chapter.

[10] Gotth. Fischer *on the different forms of the intermaxillary bone in different animals,* with plates, in German. Leipzig, 1800, 8vo.

[11] Vesalius *de c. h. fabricâ,* p. 46, fig. 1.

as have no inciſor teeth at all; viz. the *duck-billed animal*, and the *armadillo*. It is even found in thoſe mammalia, which are wholly deſtitute of teeth; as the *anteater*, and the proper *whales*[12]. It is joined to the neighbouring bones by ſutures, which run exteriorly by the ſide of the noſe and ſnout, and which paſs, towards the palate, cloſe to the foramina inciſiva[13]. Its form and magnitude vary ſurpriſingly in ſeveral orders and genera of mammalia. It is ſmall in many feræ; as alſo in the *walruſs (Trichecus)*. In the *glires* * it is generally remarkably large; viz. in the *beaver* and *marmot*. It is alſo large in the *hippopotamus*, *porpoiſe*, and *cachalot (phyſeter macrocephalus)*. Its form is very remarkable in the *ornithorhynchus*, where it conſiſts of two hooklike pieces, joined by a broad ſynchondroſis [14].

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[12] On this account I prefer the term intermaxillary bone, to that of *os inciſivum*, which is employed by HALLER.—BLAIR, in his excellent account of the anatomy of the elephant, calls it *os palati;* and VITET *os maxillaire intérieur*.

[13] In human crania, at leaſt thoſe of the fœtus, and young children, there is at the ſame part a ſmall tranſverſe ſlit near the foramen inciſivum, of which FALLOPIUS gave the following accurate account in the year 1561: "I find this diviſion to be rather a ſlit than a ſuture, ſince it does not ſeparate one bone from the other, nor does it appear exteriorly, nor join two bones; which is the office of ſutures." *Obs. Anat.*

Hence I was much ſurpriſed to find VICQ D'AZYR in 1780 diſcover in this point an unexpected reſemblance between the cranium of the human ſubject, and of quadrupeds. *Mem. de l'Acad. des Sc.* 1780.

In the celebrated diſpute of the 16th century, whether GALEN's oſteology was derived from the ſkeleton of man or the ape, INGRASSIAS argued for the latter ſide of the queſtion, from GALEN's having aſcribed an intermaxillary bone to the human ſubject. And the ſame author, in his claſſical "*Commentarii in Galeni Librum de Oſſibus*," Panorm, 1603, fol. particularly points out the parts; "where GALEN, led aſtray by the diſſection of apes, deviates from the true conſtruction of the human body."

§ 15. The above-mentioned *anterior palatine holes*, or *foramina inciſiva* are double in moſt mammalia, as in man. They are much larger in quadrupeds than in the human ſubject: in the

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* Its great ſize in theſe animals is accounted for by the magnitude of the inciſor teeth, which it contains. T.

[14] I cannot repeat here, what I have obſerved in my book *De Generis Humi. Var. Nat.* on the ſubject of the intermaxillary bone; of which, as is there ſtated, not the leaſt trace could be diſcovered in the crania of ſome *apes* and *baboons*, although the individuals were young. Can it be ſuppoſed, that in theſe inſtances it was conſolidated to the neighbouring bones at a young period of life, when all the other ſutures were in a ſtate of perfection?

Fischer could diſcover no trace of this bone in ſeveral mammalia of other orders; viz. the *three-toed ſloth, (bradypus tridactylus)* and the *horſe-ſhoe bat (veſpertilio ferrum equinum)*. See his work above quoted. Yet he admits it as poſſible that the bone may have been broken off, at leaſt in the *ſloth*. In ſhort, all the exceptions, which we have juſt enumerated, require a more accurate inveſtigation in numerous and perfect ſpecimens from different periods of life. (See note (F) at the end of the chapter.)

pecora and the *hare* they are remarkably long and broad [15].

§ 16. There are remarkable impreſſions in the upper jaw of moſt *pecora*, near the naſal bones, ariſing from the ſituation of the *ſinus ſebacei.* This part has a reticular ſtructure in the *hare*, which approximates in that, as well as in many other points, to the formation of the ruminant animals.

§ 17. In the *zygoma* we obſerve ſeveral important differences, immediately derived from the organs of maſtication [16]. It is commonly formed by the junction of the *cheek-bone* with the *os temporis.* In ſeveral *web-footed* and *digitated mammalia*, (viz. the *otter*, *beaver*, *opoſſum*, *guinea-pig*,) there is a peculiar bone interpoſed between theſe. It is ſtraight, and almoſt of a thread-like ſlenderneſs in the mole. It is of immenſe ſtrength, and includes a large ſpace towards the cranium, for lodging the powerful muſcles which move the lower jaw, in ſeveral *carnivorous animals*, as the *tiger*, and in ſome *glires*, as the *beaver*. In the *rat*, and ſome others, it is convex below; in the *weaſel*, above. It is remarkable in the *ſloth* for a large deſcending proceſs, which comes from the os malæ *.

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[15] In many inſtances, as in the *lion*, the openings of theſe large foramina are very viſible in the palate, during life. See J. RIDINGER's *Delineation of the tame lion, which was exhibited in Germany in* 1760, fol.

[16] See PINEL *Recherches ſur une nouvelle methode de claſſification des quadrupêdes*, in the 1ſt vol. of the *Actes de la Societé d' Hiſtoire Naturelle de Paris.*

§ 18. The *elephant* poſſeſſes only a kind of imitation of naſal bones. In moſt *apes*, and even in the *orang outang*, there is a ſingle, triangular, and and very ſmall naſal bone. In the greater number of true quadrupeds, there are two oſſa naſi, frequently of very conſiderable magnitude. This is the caſe in the *pecora* and *hare;* alſo in the *horſe*, *pig*, &c. In the *rhinoceros*, the oſſa naſi, which ſupport the *horn*, are very ſoon conſolidated together.

§ 19. The lacrymal bones *(oſſa unguis)* are entirely wanting in the *elephant.* They are particularly large in the *pecora;* and above all in the *antelope*. They are alſo very remarkable in the *opoſſum.*

§ 20. The orbits differ very much in their direction, capacity, and depth. They have for the moſt part a lateral direction. In the *ſimiæ* they are directed forwards, as in man: but they lie much more cloſely together than in the human ſubject. In the *beaver* they point upwards.

They are completely cloſed in the quadrumanous mammalia. In the *pecora* and *ſolidungula* they have a circular margin in front; but the outer part is deficient behind. In the *feræ* and ſeveral *glires* the outer part of their margin is alſo deficient. The depth of theſe cavities is equally various. In many caſes they are ſo ſuperficial as ſcarcely to deſerve the name of orbit; viz. the *mole*, and *anteater*. HALLER's aſſertion, that man poſſeſſes a larger bony orbit than any animal, is erroneous. The orbit of the *cat* is comparatively larger, as alſo that of ſeveral *makis*, *(lemur)*. See the delineation of their crania in FISCHER's valuable "*Anatomy of the Maki.*" Frankfort 1804, 4to *.

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* See note (G) at the end of the chapter.

§ 21. In mammalia, which have horns, theſe parts grow on particular proceſſes of certain bones of the cranium. In the *one horned rhinoceros*, they adhere to a rough, and ſlightly elevated ſurface of the vaſt naſal bone. The front horn of the two horned ſpecies has a ſimilar attachment; the poſterior reſts on the os frontis [17]; as thoſe of the horned pecora do. Two kinds of ſtructure are obſerved in the latter: there are either proper horns, as in the genera of the *ox*, *goat*, and *antelope*, or bony productions, as in the genus *cervus*, which includes animals of the deer kind. Theſe are alſo called

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* See note (H) at the end of the chapter.

[17] GEOFFROY in *Mémoires de la Societé d' Hiſtoire Naturelle de Paris*, an. 7. cahier 1.

horns in Engliſh, or ſometimes *antlers* : in French *bois de cerf*. In the former, the external table of the frontal bones is elongated into a proceſs, which contains a continuation of the frontal ſinuſes, except in the *antelope*. Its external vaſcular ſurface ſecretes the horn, which covers this proceſs like a ſheath. In the ſtag kind[18] (in the male[19] only in moſt genera), the frontal bone forms a ſhort flattened prominence, from which the proper *antler* immediately ſhoots forth. It is renewed every year, and is covered, during the time of its growth, with a hairy and very vaſcular ſkin *[20]. The little horns of the *giraffe* hold a middle place between theſe two diviſions. In their form, ſtructure, and permanent duration, they reſemble the frontal proceſſes of the proper horns: in their hairy covering they approach to the branches of the ſtag kind[21].

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[18] I have collected about twenty inſtances, from the middle of the 16th century downwards, in which *horned hares* are ſaid to have been found, with ſmall branches like thoſe of the *roebuck*, both in different parts of Europe, and in the Eaſt Indies. Were this fact aſcertained, it would furniſh another ſtriking point in which theſe animals reſemble the *pecora*. The fact is ſuſpicious, becauſe I have not yet been ſufficiently ſatisfied of a ſingle inſtance in which the horns were on the hare's head, although every trouble has been taken to procure information; and they appear in the drawings, which I poſſeſs, by far too large for a hare.

[19] Anomalous inſtances, in which the females have poſſeſſed horns, may be ſeen in STAHL, *de cornu cervi deciduo*, Hal. 1699. LEOPOLD, *diſs. de alce*, Bas. 1700. HOY in the *Linnean Trans.* vol. 2. p. 356.

I poſſeſs a coloured drawing, and accurate account of a horned roe, which was ſhot in Hanover.

* See note (I) at the end of the chapter.

[20] The annual reproduction of theſe horns conſtitutes, in many points of view, one of the moſt remarkable phænomena of animal phyſiology. It affords a moſt ſtriking proof; 1ſt,

§ 22. The ſkeleton of quadrupeds deviates more from that of man in the form of the lower jaw bone, than in any other part. This difference conſiſts chiefly in the want of a prominent chin; that pecu-

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1ſt, of the power of the nutritive proceſs, and of the rapid growth, which is dependant on this in warm-blooded animals. For the horn of a ſtag, which may weigh a quarter of a hundred, is completely formed in ten weeks. 2dly, of a limited duration of life in a part of an animal, entirely independent on the life of the whole animal; (which in the ſtag extends to about 30 years). 3dly, of change of calibre in particular veſſels. For the branches of the external carotid, which ſupply the horn, are ſurpriſingly dilated during its growth; and recover their former area when that proceſs has ceaſed. 4thly, of a peculiar ſympathy, which is manifeſted between the growth of the horns, and the generative functions. For caſtration, or any eſſential injury of the organs of generation, impedes the growth, alters the form, or interrupts the renewal of the horns. See Russell's experiments in his "*Economy of Nature in acute and chronical Diſeaſes of the Glands.*" It has alſo been aſſerted, but without a ſufficient proof hitherto, that injuries of the newly formed horn render the ſtag impotent for ſome time. *Berlin Soc. of Inquirers into Nature*, vol. 4. p. 360.

[21] The frontal proceſs in the young giraffe, conſtitutes an epiphyſis, which is connected to the frontal bone by a cruſt of cartilage; but afterwards becomes conſolidated to the bone.

liar characteriſtic of the human countenance; which exiſts in every race of mankind, and is found in no other inſtance whatever. Man has alſo the ſhorteſt lower jaw in compariſon with the cranium; the elephant perhaps approaching the neareſt to him in this character[22]. The ſame bone is further diſtinguiſhed by the peculiar form and direction of its condyle. The articulation of theſe proceſſes varies according to the ſtructure of the maſticating organs. They are both ſituated in the ſame ſtraight horizontal line in the *feræ;* their form is cylindrical; and they are completely locked in an elongated glenoid cavity, whoſe margins are ſo extended before and behind the condyle, that all rotatory motions are rendered impoſſible, and hingelike movements only allowed. This ſtructure is moſt ſtrikingly exemplified in the *badger*, where the cylindrical condyles are ſo cloſely embraced by the margins of the articular cavity, that the lower jaw, (at leaſt in the adult animal,) is ſtill retained in its ſituation, after the ſoft parts have been entirely removed by maceration. In many herbivorous animals (in the moſt extenſive ſenſe of the term) theſe condyles are really rounded eminences; viz. in the *elephant* and *beaver*. Their ſurface is flattened in the *pecora*, which have alſo the lower jaw narrower than the upper, ſo that the two ſets of teeth do not meet together, when the mouth is ſhut; but are brought into contact by the free lateral motion, which takes place in rumination. The two condyles lie parallel to each other in a longitudinal direction in many *glires*; viz. in the *hare*, where, (as in the *anteater*) the coronoid proceſs is almoſt entirely wanting. This proceſs is on the contrary very conſpicuous in the *giraffe*. The *cetacea* have the articular ſurface of the lower jaw turned almoſt directly backwards [23] *.

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[22] See PINEL *ſur les os de la tête de l' Elephant* in the *Journal de Phyſique*, tom. 43. p. 54.

There are on the whole, few other bones in the ſkeleton of mammalia, of ſuch various forms as the lower jaw. The moſt anormalous formation of this bone is the ſhovel-like ſurface of its anterior part in the *duck-billed animal*.

We have laſtly to obſerve that the two halves of the lower jaw are connected throughout life, in many mammalia, by a mere ſynchondroſis; which is eaſily ſeparated by boiling or maceration. This is the caſe in many *feræ*, *glires*, and *cetacea*. They are conſolidated into one piece, as in the human ſubject, at an early period, in the *quadrumana*, as alſo in the *horſe*, *horned cattle*, *pig*, *elephant*, &c.

§ 23. The jaws of mammalia contain teeth † [24] with

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[23] The ſingular, but very common error, of conſidering the halves of the lower jaw of the whale, as ribs, has been already refuted by RONDELET, *de piſcibus*, p. 53.

* See note (K) at the end of the chapter.

† See note (L) at the end of the chapter.

[24] See J. G. DUVERNEY, *Lettre contenant pluſieurs nouvelles Obſervations ſur l' Oſteologie*, Paris, 1689, 4to.

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with a very few exceptions: the proper whales, *(balænæ)*, the *manis*, *(ſcaly lizard)*, and the *American anteaters* are the only genera entirely deſtitute of theſe organs *.

The ſubſtance and texture of the teeth are different from thoſe of all other bones. The enamel which covers the crown of the tooth, is characteriſed by its peculiar hardneſs, (ſparks of fire may be produced by ſtriking it againſt ſteel), as well as by the want of animal matter, with which the bony part of the crown, as well as the fang of the tooth are copiouſly provided. It ſeems to be wanting in the tuſks of the *elephant*, as alſo in thoſe of the *walruſs*, and of the *narwhal*, *(monodon*, *ſea-unicorn)*. Yet theſe are all ſurrounded by an external thin coat of a different ſubſtance from the body of the tooth. Theſe teeth have indeed ſome peculiarity in their texture; the ivory of the elephant's tuſks in particular is unlike any other ſubſtance † [25]. In

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J. J. Kober *de dentibus, eorumque diverſitate*, Auguſt 1774, 4to.

P. M. G. Broussonet *Comparaiſon entre les dents de l' homme et celles des Quadrupedes*, in *Mem. de l' Acad. des Sc.* de Paris, 1787.

* See note (M) at the end of the chapter.

† See note (N) at the end of the chapter.

[25] Not to mention other peculiarities of *ivory*, which have induced ſome modern naturaliſts to conſider it as a ſpecies of *horn*, the difference between its ſtructure and that of the bone of teeth is evinced in the remarkable pathological phenomenon, reſulting from balls, with which the animal has been ſhot when young, being found on ſawing through the tooth, imbedded

In ſome animals the crowns of particular teeth are diſtinguiſhed by peculiar colours. The inciſors of ſome *glires*, as the *beaver*, *marmot*, and *ſquirrel*, are of a nut-brown colour on their anterior ſurface, and the molar teeth of ſeveral *biſulca*, (cloven-hoofed animals), as well as of the elephant, are covered by a very hard black ſubſtance of a vitreous appearance [26].

§ 24. It

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imbedded in its ſubſtance in a peculiar manner. Haller employed this fact, both to refute Duhamel's opinion, of the formation of bones by the perioſteum, like that of wood by the bark of a tree; as well as to prove the conſtant renovation of the hard parts of the animal machine. It is ſtill more important in explanation of that "*nutritio ultra vaſa*," which is particularly known through the Peterſburg prize diſſertation. Inſtances of the fact above-mentioned may be ſeen in Buffon, 4to. ed. tom. ii. p. 161. in Gallandat *over de Olyphants Tanden* in the *Verhandelingen der Genootſch, te Vliſſingen* p. 352. tom. 9. and in Bonn *deſcr. theſauri Hoviani*, p. 146. In all theſe caſes the balls were of iron. I poſſeſs a ſimilar ſpecimen.

But there is a ſtill more curious example in my collection, of a leaden bullet contained in the tuſk of an Eaſt Indian elephant, which muſt have been equal in ſize to a man's thigh, without having been flattened. It lies cloſe to the cavity of the tooth; its entrance from without is cloſed as it were by means of a cicatrix; and the ball itſelf is ſurrounded apparently by a peculiar covering. The bony matter has been poured out on the ſide of the cavity in a ſtalactitic form. (See note (Θ) at the end of the chapter.)

[26] This black vitreous matter is ſometimes covered with a cruſt of a metallic ſhining bronze colour; particularly in the

domeſticated

§ 24. It is difficult to frame a claſſification of the teeth, which ſhall be generally applicable, and at the ſame time intelligible. Their ſituation affords perhaps a more eligible baſis of arrangement than their form, ſince that is the ſame throughout, in ſome inſtances, as the *cachalot* and *porpoiſe*. They may therefore be diſtributed into the three claſſes of *front teeth*, *corner teeth*, and *back teeth* *.

§ 25. The front teeth in the upper jaw, are thoſe which are implanted in the intermaxillary bone, (the tuſks of the elephant muſt therefore be included); in the lower jaw, ſuch as correſpond to theſe, or to the anterior margin of the intermaxillary bone, in animals which have no upper inciſors. Their number and form vary conſiderably. In the *glires* their cutting edge is formed like a chiſſel, particularly in the lower jaw, whence J. Hunter called theſe animals "*ſcalpris dentata*." In ſome caſes, as the *beaver*, and the *domeſtic mouſe*, the lower ones have remarkably long roots †. In the hare there are two very ſmall teeth placed juſt behind the large ones. The crowns of the front, as well as of the back teeth, form flat prominences in the walrus. The front extremity of the lower jaw,

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domeſticated horned cattle, and ſheep. See Stobæus *de inauratione ſpontaneâ dentium quorundam animalium* in *Act liter. Suecic.* vol. 3. p. 83, 1733.

* See note (P) at the end of the chapter.

† See note (Q) at the end of the chapter.

with its teeth, extends in the dolphin *(delphinus delphis)* much beyond the correſponding part of the upper jaw, contrary to what happens in other animals. The lower fore teeth of moſt mammalia have a more or leſs oblique poſition; while in man they are perpendicular. The *orang-outang* of Borneo, is the only animal, which at all approaches to the human ſtructure in this point.

§ 26. The corner teeth *(canini)* of the upper jaw, lie cloſe to the intermaxillary bone; hence the remarkable ſpiral tuſk of the *narwhal*[26], and the tuſks of the *walrus* belong to this diviſion. In many *baboons*, and moſt particularly in the larger predacious mammalia, theſe teeth are of a terrific ſize; in the latter animals, the whole profile of the anterior part of the cranium, forms a continuous line with theſe teeth; which is very viſible in the *tiger*. The canine tuſk of the *babirouſſa*, which are very long, and recurved ſo as nearly to deſcribe a complete circle, preſent the moſt curious ſtructure. Their utility to the animal, appears quite obſcure, when their length, direction, and ſmallneſs are conſidered. The ſmall canine teeth, which are ſituated juſt behind the larger ones, in all the ſpecies of the bear [27] kind, are alſo remarkable.

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[26] I muſt refer to the 5th part of my "*Delineation of Subjects, relating to Natural Hiſtory*;" for what is there ſaid on the queſtion, whether the *narwhal* has really one or two of theſe teeth. (See note (R) at the end of the chapter).

§ 27. The back teeth are the moſt univerſal; ſince, when mammalia have any teeth at all, they are of this deſcription, although the front and canine teeth may be wanting; as in the *armadillo*, and the *ornithorhynchus*. The *narwhal* makes the only exception, as it is perfectly toothleſs, if we except the long tuſk. The form, ſtructure, and relative ſituation of the back teeth vary very conſiderably. In many *quadrumana*, as in man, the two front ones[28] are ſmaller in the crown, and more ſimple in the fang than the poſterior. Whence J. HUNTER calls them *bicuſpides*, and reſtricts the name of *molares* to the latter [29].

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[27] This is the caſe in the brown bear of the Alps, of which I have three crania; with a black American; with one whoſe country is unknown, belonging to the National Muſeum at Paris; and with the Polar bear; of all which, I poſſeſs excellent drawings, through the kindneſs of profeſſor CUVIER. Theſe ſmall teeth are wanting in the foſſil remains of a prodigious bear *(urſus ſpelæus)*, towards the oſteology of which, I have a large collection, from the three moſt celebrated caverns in Germany, viz. that of SCHARZFELDER in the HARZ, of GAILENREUTER in the FICHTELBERG, and of ALTENSTEINER in THURINGERWALD.

[28] In ſome *apes* and *baboons*, the front bicuſpis of the lower jaw, has a peculiar formation, being elevated into a ſharp point, like thoſe of the *feræ*. See the excellent repreſentation of the cranium of the mandril *(Simia Maimon)* in CHESELDEN'S *Oſteography*.

The molar teeth of *feræ* have the crown entirely covered with enamel [30]; while in ſeveral [31] *glires*, in the *ſolidungula*, *pecora* [32], and moſt *balenæ*, bony ſubſtance may be ſeen at the extremity of the tooth, intermixed in a tortuous line with vertical productions of enamel [33] *. In many animals, which feed on graſs, and do not ruminate, as the *ſolidungula* and the *elephant*, the broad crowns of the grinding teeth lie chiefly in an horizontal direction towards each other. In moſt *pecora*, on the contrary, their ſurface, which forms a zig-zag line, is oblique; the outer margin of the upper teeth, and the inner margin of the lower teeth, being the moſt prominent. In moſt predacious animals, particularly of the lion and dog kind, the crowns of the molar teeth are compreſſed, and terminate in pointed proceſſes, the lower ones ſhutting within the upper; ſo that in biting they interſect each other, like the blades of a pair of ſciſſars, in conſequence of the firm hinge-like articulation of the cylindrical condyle.

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[29] I find, that the difference between the bicuſpides and molares, is noticed in the firſt anatomical compendium, which was compiled from human bodies, viz. the celebrated *Anatomia partium Corp. human.* written by MONDINI in the firſt half of the fourteenth century. For he enumerates in each jaw four "*maxillares*," and ſix "*molares*," beſides the inciſor and canine teeth, p. 370, of the claſſical edition, which is accompanied with BERENGAR's Commentaries. I have alſo found, that this diſtinction of the two kinds of grinders, is noticed in that famous volume of admirable anatomical drawings, by the incomparable LEONARDO DE VINCI, which is preſerved in his majeſty's library.

[30] This is the caſe alſo in the monſtrous foſſile *animal incognitum* of the Ohio *(mammut Ohioticum)*, which has been called the carnivorous elephant. See the 2d part of "*Delineations of Subjects relating to Natural Hiſtory*, tab. 19.

[31] I ſay, "ſeveral;" becauſe in ſome, as the *marmot*, the whole crown is covered with enamel.

[32] For the internal ſtructure of the molar teeth of *pecora*, ſee HOLLMANN *de Oſſibus Foſſilibus*, in the *Commentar. Reg. Soc. Scient. Götting.* t. 2. p. 263. And SCHREGER, in ISENFLAMM and ROSENMULLER's "*Contributions towards Anatomy*," vol. 1.

[33] The ſpecifically different forms of the layers of enamel, in the *African* and *Aſiatic elephants*, may be ſeen in the "*Delineations*," &c. part 2. tab. 19.

* See note (S), at the end of the volume.

§ 28. Certain claſſes of the teeth are entirely wanting in ſome orders, claſſes, and genera of quadrupeds; as the upper front teeth in the *pecora*, the lower in the *elephant*, both in the *African rhinoceros*, and the canine in the *glires*. In other inſtances, the different deſcriptions of teeth, particularly the canine and molar, are ſeparated by conſiderable intervals; this happens in the *horſe* and *bear*. There is no animal, in which theſe parts are of ſuch equal height, and ſuch uniform arrangement as in man *.

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* See note (T), at the end of the chapter.

§ 29. The want of ſatisfactory obſervations [34], prevents us from ſaying much on the change of the teeth, particularly in wild animals. Some erroneous opinions of former times, as, for inſtance, that the domeſticated pig changes its teeth, and that the wild animal does not, hardly require an expreſs contradiction in the preſent day. During the time of change in the *feræ*, particularly in the *dog* and *otter*, the number of their canine teeth often ſeems doubled; ſince the permanent ones cut the gum, before the deciduous have fallen out. Apes, like the human ſubject, have no bicuſpides among the deciduous teeth: but there are, inſtead of theſe, two proper molares on either ſide of the jaw [35]. The change of the teeth takes place in the *elephant*, in a very remarkable manner. The new permanent tooth comes out behind the milk tooth [36]; the vertical layers of which are gradually removed [37], as the formation of the latter advances [38] *. There is, however, perhaps no animal of this claſs, in which the firſt appearance, and ſubſequent removal of the deciduous teeth take place, at ſo late a period of life as in man.

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[34] See the detailed deſcription of the change of the teeth in the horſe, by TENON, "*Sur une Methode particulière d'etudier l'Anatomie*, in the *Mem. de l'Inſtitut. National*, t. 1. p. 558.

[35] In the ſkull of a young *orang-outang* of Borneo, which I poſſeſs, through the kindneſs of Mr. VAN MARUM, there are no bicuſpides.

[36] This is excellently ſeen in the cranium of a young *African elephant*, belonging to the muſeum of the Academy.

[37] See Prof. BRUGMAN's remarks on this ſubject, in VAN MAANEN, *Diſ. de Abſorptione Solidorum.* Lugd. Bat. 1794.

* See note (U), at the end of the chapter.

[38] I have given a drawing in the Peterſburgh *Prize Diſſertation*

§ 30. The crown[39] of the tooth is gradually worn down by the act of maſtication, and receives from this cauſe, a kind of poliſhed ſurface, which is eſpecially obſervable in the canine teeth of the *pig* and *hippopotamus*. The age of the horſe is determined by the appearance of the front teeth.

§ 31. From the head of mammalia, we proceed to conſider the trunk, according to its diviſion into the three principal parts of *ſpine*, *pelvis*, and *cheſt*. The former of theſe is the moſt conſtant part of the ſkeleton; as it belongs to all red-blooded animals without exception, and is not found in a ſingle white-blooded one.

ſertation on Nutrition, 1789, 4to. of the peculiar formation of theſe vertical layers in the molar teeth of the *elephant*, before they appear through the gum; and particularly of the manner, in which the enamel exudes from the bony ſubſtance in ſmall moleculæ.

[39] Hence it has been obſerved in the *glires*, that when the upper or lower pair of inciſors is loſt, the oppoſite teeth grow out to a monſtrous length. A ſimilar growth takes place, when theſe animals are confined to ſoft food. See MORTON's *Natural Hiſtory of Northamptonſhire*, p. 445.; and ACHARD's *Chymico-phyſical Writings*, p. 161. (See note (Q), at the end of the chapter).

§ 32. It is remarkable, that the animals of this claſs conſtantly agree in the number of their cervical vertebræ. The *giraffe*, or the *horſe*, have neither more nor fewer than the *mole* or *ant-eater*. They are always ſeven, as in the human ſubject. An unexpected irregularity has been diſcovered by CUVIER in the *three-toed ſloth;* it has nine vertebræ of the neck. In ſome *cetacea*, on the contrary, there are only ſix *; and, in theſe animals, four or five are generally conſolidated together. The *atlas* is diſtinguiſhed in the *feræ* by its immenſe ſtrength, and by the vaſt ſize of its tranverſe proceſſes [40]: the vert. dentata is equally conſpicuous for its ſpinous proceſs †.

§ 33. The number of dorſal vertebræ is determined by that of the ribs, which will be ſpoken of preſently. In the long-necked quadrupeds, as the *horſe*, *giraffe*, *camel*, and other *pecora*, as well as in thoſe animals whoſe head is very heavy, as the *elephant*, the ſpinous proceſſes of the anterior dorſal vertebræ are exceedingly long, for the attachment of the great ſuſpenſory ligament of the neck (*ligamentum nuchæ*).

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* See note (V), at the end of the chapter.

[40] The connection which this ſtructure has with the teeth and jaws of theſe rapacious animals, is pointed out by Euſtachius, *De Dentibus*, p. 86.

† See note (W), at the end of the chapter.

§ 34. The lumbar vertebræ vary much in number. The *elephant* has only three; the *camel* ſeven. Some *quadrumana,* as the *mandrill,* have the latter number. The *horſe* has ſix; the *aſs* five. (*Mules* have generally ſix, but ſometimes only five.) Moſt quadrupeds have the proceſſes of theſe vertebræ turned forwards (which is upwards [41] in the *ape*, in its ordinary poſition). The tranverſe proceſſes are remarkably large in many *ruminantia,* as alſo in the *hare.*

§ 35. The form and proportions of the *ſacrum* are ſtill more various. The number of its vertebræ, as they are called, varies in the different ſpecies of the ſame genus. Thus, in moſt [42] of the *ſimiæ*, it conſiſts of three pieces; in the * *orang-outang* of four [43]; in the *chimpanſé* [44] of five. This bone is diſtinguiſhed in the horſe by large lateral proceſſes at its anterior extremity; and in the *mole* by a thin ſharp edged plate, formed by the union of its ſpinous proceſſes *. As the *cetacea* have no pelvis, they cannot be ſaid to poſſeſs a ſacrum.

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[41] GALEN, in his Oſteology, deſcribes the tranſverſe proceſſes as having this direction; from which circumſtance, as well as from his deſcription of the *ſacrum* and *os coccygis*, and ſeveral other paſſages, VESALIUS ſhewed that the work was drawn up from the examination of apes, not of the human ſubject. See his *Epiſtola rationem modumque propinandi radicis chynæ decocti pertractans*, 1546. p. 49.

[42] VESALIUS *de Corp. Hum. Fabricâ*, p. 99.

[43] CAMPER ſtates, that the ſacrum of this animal has three pieces: in my ſpecimen, however, there are manifeſtly four.

[44] TYSON's *Anatomy of a Pigmy*, edition of 1751, p. 89.

* See note (X), at the end of the chapter.

§ 36. The os coccygis is prolonged, ſo as to form the tail of quadrupeds; and conſiſts therefore, in many caſes, of a great number of vertebræ. In the *cercopithecus morta* there are 22; in the *cerc. paniſcus* 32; in the *two-toed ant-eater* 41[45]. (See note (Y), at the end of the chapter.)

§ 37. The oſſa innominata, together with the ſacrum, conſtitute the pelvis[46]. There is ground for affirming, although the aſſertion may appear paradoxical, that no animal but man has a pelvis; for in no inſtance have the bones of this part that baſon-like appearance, when united, which belongs to the human ſubject. Thoſe *apes*, which moſt nearly reſemble man, have the oſſa innominata much elongated; and in the *elephant*, *horſe*, &c. the length of the ſymphyſis pubis detracts from the reſemblance to a baſon. In ſome inſtances, as in the *beaver* and *kangaroo*, the oſſa pubis are not united by ſynchondroſis, but conſolidated into one piece by a bony union *. They are, on the contrary, ſeparate in the *ant-eaters*, in the ſame manner as they are found in birds. The cavity of the pelvis is ſo narrow in the *mole*, that it cannot hold the organs of generation and neighbouring viſcera, which lie therefore externally to the oſſa pubis. In the *kangaroo* [47], and other *marſupial* [48] *animals*, the ſuperior, or rather the anterior margin of the oſſa pubis, is furniſhed with a peculiar pair of ſmall bones, (*oſſa marſupialia*, or *cornua pelvis abdominalia*) ſomewhat diverging from each other, and running towards the abdomen. They have an elongated and flattened form, and belong excluſively to theſe animals. But in the Philoſ. Tranſ. of 1802, it is ſtated by Mr. Home, that the ornithorhynchus has ſomething of this kind. They ſupport the abdominal pouch in the female, but are alſo found in the male; at leaſt in ſome ſpecies [49]. Cetaceous animals have no hind feet, nor oſſa innominata, conſequently no pelvis: they have, however, a pair of ſmall bones at the lower part of the belly, which may be compared to the oſſa pubis [50].

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* A ſomewhat ſimilar ſtructure is found in the *armadillo;* in which animal, the whole pelvis has a very anomalous formation. Its ſkeleton, which is altogether very curious, is accurately deſcribed by WIEDEMANN, in his "*Archives of Zoology and Zootomy*," 1 vol. p. 106. There is alſo a delineation of the ſkeleton of an armadillo, prefixed to the 8th chapter of CHESELDEN'S *Oſteography*.

[45] When an opoſſum or monkey loſes a portion of the tail, (an accident which has often led to confuſion in determining the ſpecies) a peculiar knotty excreſcence, ſometimes of a carious appearance, takes place at the truncated extremity.

[46] B. G. SCHREGER, *Pelvis Anim. Brutorum cum Humanâ Comparatio.* Lipſ. 1787. 4to. AUTENRIETH et FISCHER, *Obſervations de Pelvi Mammalium.* Tubing. 1798-9.

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[47] E. HOME, *On the Mode of Generation of the Kangaroo.* Philoſ. Tranſact. 1795.

[48] DAUBENTON, vol. 10. tab. 51. (I refer here, and in other places, where a ſimilar quotation occurs, to the original 4to. edition of Buffon's work. It cannot, with propriety, be quoted under the name of Buffon, ſince it is well known, that the zootomical part was furniſhed by Daubenton, and has been omitted in moſt of the ſubſequent editions.)

* See note (Z), at the end of the chapter.

§ 38. The thorax in moſt, if not all animals of the claſs mammalia, is narrower, and on the contrary, deeper from the ſpine to the ſternum, than in man. The leſs marked flexure of the ribs of animals, and the elongation of their ſternum give riſe to this peculiarity. The long legged animals, as the *giraffe*, and thoſe of the ſtag kind, poſſeſs this keel-like form of the cheſt (*thorax carinatus*) in the moſt ſtriking degree.

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[49] This is one of thoſe inſtances, illuſtrating the ſubject of the *niſus formativus*, which occur ſo abundantly in zootomy. It ſhews, in the function of generation, an union of the *teleological* and *mechanical* principles, which were formerly thought to be incompatible with each other. The formation of this anomalous pair of bones, for the purpoſe of ſupporting the abdominal pouch of the female, is a clear inſtance of the teleological principle, that is, it ſhews a peculiar part, formed for a certain purpoſe. Their exiſtence in the male, where the end and purpoſe of their formation do not exiſt, ſhews the mechanical principle; as if they had been merely framed, in compliance with ſome general model, for the ſtructure of the ſpecies.

[50] RONDELET, *De Piſcibus*, p. 461. TYSON's *Anatomy of a Porpoiſe*. London, 1680, p. 28.

§ 39. In a very few mammalia, as ſome *bats* and *armadillos*, there is a pair of ribs leſs than in man; but in the greater number of this claſs there are more. Several *quadrumana* have 14 pairs; the *horſe* 18; the *elephant* 19[51]; the two-toed ſloth (*bradypus didactylus*) 23. The two-toed ant-eater (*myrmecophaga didactyla*) has 16 pairs, which are remarkably broad, ſo that the back and ſides of the ſkeleton, as low as the oſſa innominata, appear like a coat of mail. (See note (A a) at the end of the chapter).

§ 40. The ſternum in moſt of the mammalia is cylindrical, and jointed. This ſtructure occurs even in the *quadrumana* and the *bears*, whoſe ſkeletons, in other reſpects, reſemble the human. The form of this bone is the moſt ſingular in the mole; where its anterior[52] extremity is prolonged into a proceſs, almoſt reſembling a ploughſhare, lying under the cervical vertebræ, and parallel with them. (See the note (B b) at the end of the chapter.)

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[51] This at leaſt is the caſe in the ſkeleton of the Aſiatic elephant at CASSEL. BLAIR found the ſame number in the individuals of which he has given ſo excellent an account; and a manuſcript Italian deſcription of the elephant, which died at FLORENCE in 1657, confirms this ſtatement. ALLEN MOULINS on the contrary (in his *Anatomical Account of the Elephant burned in Dublin.* London, 1682, 4to) and DAUBENTON repreſent the number of pairs as 20.

[52] It is hardly neceſſary to remind the readers, that the terms

§ 41. We proceed to ſpeak of the extremities, as they are called, which, although they vary conſiderably in the claſs of mammalia, may, on the whole, be compared to thoſe of man in their chief component parts, and in the mode[53] in which theſe are connected together. (See note (C c) at the end of the chapter).

§ 42. The clavicle has been ſaid, even by ſome

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terms *anterior*, *poſterior*, *ſuperior*, and *inferior* are always applied to quadrupeds with a reference to the horizontal poſition of their body. Conſequently the term *anterior* deſignates thoſe parts, which, in the erect poſition of the human body, are *ſuperior*; and ſo of the others.

[53] The paſſages of ARISTOTLE, *Hiſt. Anim.* 2. 1. and *de Inceſſu Anim.* c. 11. and one of PLINY ii. 102. have given riſe to the ſingular miſtake of ſuppoſing that the elbow and knee of quadrupeds are bent in a direction exactly oppoſite to that of the human ſubject. The error muſt have ariſen from the ſhortneſs of the thigh and arm bones, which lie cloſe to the trunk, particularly in long-legged quadrupeds, and do not project freely as in man, the *quadrumana*, the *bear*, the *elephant*, &c. Hence the different bones of the extremities in theſe animals, have been compared to ſuch parts in the human body as do not in reality correſpond with them. See on this ſubject FAB. AB AQUAPEND, *de mocu locali animalium ſecundum totum*, in his *Oper. Anat.* p. 343, ALBINUS's ed. and BARTHEZ *des mouvemens progreſſifs de l' Homme* in the *Journal des Scavans*, January 1783. p. 34.

excellent modern zoologiſts, to be confined to LINNÆUS's order *primates* (in which he includes *man*, the *quadrumanous animals*, and *bats) :* but it exiſts in a great number of mammalia [54] beſides theſe: particularly in ſuch quadrupeds, as make much uſe of their front extremities; either for holding objects, as the *ſquirrel* and *beaver ;* or for digging, as the *mole ;* or for raking the ground, as the *ant-eater* and *hedgehog* [55]*;* or for climbing, as the *ſloth.* Many other animals have, in its place, an analogous ſmall bone, merely connected to the muſcles [56], and called by VICQ-D'AZYR *os claviculare* to diſtinguiſh it from the more perfect clavicles. This is the caſe with moſt of the *feræ* [57], and ſome *glires*. Laſtly, the form and relative magnitude of the true articulated clavicles are ſubject to great variety. They are exceſſively long in the *bats.* Thoſe of the *orang-outang* have the greateſt reſemblance to the human ſubject. In the *two-toed*

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[54] J. G. HAASE, *Comparatio clavic. Anim. brut. cum humanis.* Lips. 1766, 4to. VICQ-D' AZYR *ſur les clavicules* and *les os clavic*, in *Mem. de l' Acad. des Sciences*, 1785.

[55] The uſe of the clavicles in ſome of the animals here enumerated is well pointed out by FAB. HILDANUS in his "*Short Deſcription of the excellence of Anatomy.*" Bern. 1624-8. p. 219.

[56] Hence SERAE compares it to the ſeſamoid bones. See his "*Works relating to Natural Hiſtory.*" Naples, 1766, 4to. p. 84.

[57] PALLAS *Specilegia Zoologica*, Faſci. 14. p. 41.

ant eater their form is that of a rib: their figure is moſt anomalous in the *mole*, where they are nearly cubical. They are entirely wanting in the long-legged quadrupeds with keel-ſhaped cheſt; viz. the *pecora* and *ſolidungula*; as well as in the *cetacea*. (See note (D d) at the end of the chapter).

§ 43. The ſcapula exiſts in all red-blooded animals, which have anterior extremities, or ſimilar organs of motion: conſequently in both claſſes of warm-blooded animals without exception. The form of this bone varies much even in mammalia; and particularly the relation which its three ſides bear to each other. This depends on the poſition of the bone, which is determined by the general form of the cheſt. The margin, which is turned towards the ſpine, is the ſhorteſt in moſt of the proper quadrupeds; particularly the long-legged ones with narrow cheſt; in whom the ſcapulæ lie on the ſides of the cheſt. In ſome, as the *elephant*, the *chiroptera*, moſt of the *quadrumana*, and eſpecially in man, this margin is the longeſt. The ſcapula of the *mole* has a completely anomalous figure, almoſt reſembling a cylindrical bone. The coracoid proceſs, and acromion, the two chief projections of this bone are ſtrongeſt in ſuch animals as have two long clavicles; which might have been inferred a priori.

§ 44. The remarkable varieties of the anterior extremities, properly ſo called, may be moſt conveniently conſidered according to the orders and genera of animals of this claſs. The *bat* and the *mole* preſent the moſt wide deviations from the ordinary formation of theſe parts. The radius [58] is deficient in the fore-arm of the former; or at moſt there is only a ſlender ſharp-pointed rudiment of this bone; their thumb is ſhort, and furniſhed with a hook-like nail: the phalanges of the four fingers, between which the membrane of the wing is expanded, are on the contrary extremely long and thin, almoſt like the ſpines of a fiſh, and have no nails. The *flying ſquirrel* has a peculiar ſharp-pointed bone at the outer edge of its carpus, connected to that part by means of two ſmall round bones; and incloſed in the lateral expanſion of the integuments. The form of the os humeri in the mole is altogether unparalleled; it is thin in the middle, and ſurpriſingly expanded at either extremity. The ſhovel-like paw of this animal is provided with a peculiar *falciform bone;* lying at the end of the radius. The phalanges of the fingers are furniſhed with numerous proceſſes; and have moreover ſeſamoid bones; all which, by increaſing the angle of inſertion of the tendons, contributes to facilitate muſcular motion. The animals with divided claws and hoofs have ſome peculiarities in the *metacarpus* and *metatarſus*. In the *pig* theſe parts conſiſt of four cylindrical bones. In the *pecora* before birth, there are two lying cloſe together; but they are afterwards formed into one by the abſorption of the ſeptum [59]. The *horſe* has a ſingle bone (*gamba*, Vegetius; in French *le canon*, in Engliſh the *cannon bone* or *ſhank bone*,) with a pair of much ſhorter and immoveable ones, attached to its poſterior and lateral parts, and firmly united to it, (*les poinçons* or *os epineux*, *ſtyloid* or *ſplint bones*). The main bone only is articulated to the *paſtern*, which may be compared to the firſt phalanx of the human finger; as the *coffin bone* reſembles in ſome degree the third [60] phalanx; which ſupports the nail. This laſt phalanx is very various in its form, according to correſponding variations in its horny coverings; which may conſiſt of a flat nail, or claw, or hoof, &c. (See note (E e) at the end of the chapter).

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[58] I have ſeen a foſſil preparation in the cabinet at NUREMBERG, which formerly belonged to HAGEN, conſiſting of three ſlender tubes articulated to each other length-wiſe, and ſuppoſed to be the petrified wing of a bird. From obſerving the ſimplicity and thinneſs of the middle tube, I ſhould not heſitate in aſcribing it to a large Aſiatic bat.

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[59] J. B. Covolo *De Metamorphoſi duorum Oſſium Pedis in Quadrupedibus aliquot*, Bonon, 1765, 4to. and Fougeroux in the *Mem. de l' Acad. des Sc.* 1772, p. 520.

[60] See Stubbs's moſt excellent "*Anatomy of the Horſe.*" tab. 1.

§ 45. I have ſomething to ſay reſpecting the poſterior extremities. The femur of moſt quadrupeds is much ſhorter than the tibia, and hence it hardly projects from the abdomen. In ſome few, as the *bear*, the femur is longer; this is alſo the caſe in ſome *apes*, viz. the *orang-outang*, in which, as in ſeveral other apes and baboons, the bones of the arm and fore-arm are ſurpriſingly longer than thoſe of the thigh and leg. Some, as the *elephant*, have no ligamentum teres; conſequently there is no impreſſion made on the head of the thigh bone; while it is found in others, as the *rhinoceros*[61]. The *pecora* want the fibula almoſt univerſally. The peculiar form of the *aſtragalus* (*talus*), in the ſame order is generally known from the uſe which the ancients[62] made of the bone in their celebrated game. In ſome quadrumana, as the *orang outang*, the two poſterior phalanges of their toes are remarkably curved in their ſhape; which enables them to hold the branches of trees more firmly, and is in the ſame degree unfavourable to the performance of progreſſion in an erect poſition. Cetaceous animals have no bones in their tail fins, but they have a bony compages in their thoracic fins, which completely reſembles the front extremities of the ſeal[63]. See note (F f) at the end of the chapter.

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[61] This apparently minute circumſtance, like many ſimilar ones, has aſſiſted me in determining concerning the great foſſile bones which are occaſionally found.

[62] Aristotle, *Hiſt. Anim.* l. 2. c. 1. For the various appellations of this well known bone in moſt of the European and Oriental languages; and for its form in different animals; ſee Th. Hyde, *Hiſtoria Talorum* in the 2d vol. of his *Syntagma Diſſertationum.* Oxon. 1767, 4to. p. 310.

Additional Notes to the Second Chapter.

(A) The bones of the head, in birds, are joined either by the ſquamous kind of ſuture; or by the mere appoſition of their margins: which ſpecies of union is termed *harmonia*. But they are ſoon conſolidated into a ſingle piece.

(B) The ſphenoid bone is often divided into two parts in the *quadrumana;* one of theſe forms the leſſer alæ, and anterior clinoid proceſſes; the

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[63] This is alſo the caſe with the manati *(walrus)* whoſe front extremities were formerly taken for Siren's hands, thus in BARTHOLIN *Hiſtor. Anat.* Cent. 2. p. 188.

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greater alæ, the poſterior clinoid proceſſes, and baſilar foſſa are formed by the other portion.

The two parietal bones form a ſingle piece in the *bat-kind.* The ſame circumſtance occurs in the *carnivora*, in the *pig*, *tapir*, *hippopotamus*, and *horſe*.

The frontal and parietal bones of the *elephant* become conſolidated, at an early period, with all the other parts of the cranium; ſo as to form a bony cavity, in which no trace of ſutures can be diſcerned. The parietal, occipital, and temporal bones are likewiſe ſoon joined into one piece in the *cetacea*.

The *pig*, *hippopotamus*, *tapir*, *horſe*, *ſeal*, *walrus*, and the *rodentia* have the os frontis divided by a middle ſuture into two portions.

That portion of the os temporis, which contains the tympanum, is ſeparated from the reſt of the bone by a ſuture, in the *dog*, *cat*, and *horſe;* alſo in the *ruminantia* and *rodentia*. It is ſo completely ſeparated in the *cetacea*, as to be attached to the cranium only by ſoft parts. In the *elephant*, where the other bones are conſolidated into one piece, this remains diſtinct.

The cranium of the mammalia poſſeſſes the ſame foſſæ at its baſis, as are found in the human ſubject: they are however much ſhallower; and the eminences, which define them, are much leſs ſtrongly marked than in man. This difference is very perceptible even in the *ſimiæ*, where the cavities which hold the cerebellum, are nearly on a level with the middle foſſæ of the baſis cranii; and the ſella turcica is more ſuperficial. The ſame fact is more ſtrongly marked as we arrive at thoſe animals, whoſe general ſtructure deviates more conſiderably from that of man. Thoſe mammalia, which have the *occipital foramen* ſituated at the back of the head, muſt have the *foſſæ cerebelli* moved upwards; hence that margin of the foſſæ, which is poſterior in man, paſſes acroſs the upper part of the back of the head in theſe animals. The bony projections, which bound this foſſa in ſome mammalia, are deſcribed in the chapter on the brain.

The optic foramina of the elephant commence from one canal, which receives the two optic nerves.

The foramen rotundum is ſometimes abſent, its place being ſupplied by the ſpheno-orbitary fiſſure, (*foramen lacerum*) e. g. in the *elephant* and *horſe*. The foramen ovale is alſo frequently wanting; being included perhaps in the vacancy left between the petrous portion of the temporal bone, and the body of the ſphenoid. This latter opening does not exiſt in the *genus ſimia*, nor in the *carnivorous mammalia*, nor in the *ruminantia*. It is on the contrary very large in the *elephant*, and in ſome *rodentia*.

The carotid canal does not exiſt in the *rodentia*; but the artery enters at the opening between the ſphenoid and temporal bones.

The ſtructure of the cranium preſents a very remarkable ſingularity in the *elephant.* Its two tables are ſeparated from each other to a conſiderable extent, by numerous bony proceſſes; between which are formed a vaſt number of cells, communicating with the throat by means of the euſtachian tube, and filled with air, inſtead of the bloody or medullary ſubſtance, which occupies the diplöe of animals. The uſe of this ſtructure in increaſing the ſurface for attachment of thoſe large muſcles, which belong to the lower jaw, proboſcis and neck; and in augmenting the mechanical power of theſe muſcles by removing their attachments to a greater diſtance from the centre of motion has been very ingeniouſly explained by CAMPER (*Œuvres*, tom. 2). Theſe advantages are attained by the cellular ſtructure, which we have juſt deſcribed, without augmenting the weight of the head, and this precaution is particularly neceſſary in the preſent inſtance, as the head is on other accounts more heavy and maſſy in this than in any other animal. The air cells of birds in general, and particularly thoſe which pervade the cranium in the *oſtrich*, *eagle*, and *owl* preſents examples of a ſimilar formation, attended with the ſame uſes; viz. thoſe of increaſing the bulk and ſtrength of the bone, and diminiſhing its weight.

(C) The *criſta occipitalis* is a ſharp and prominent bony ridge, projecting from the upper and back part of the cranium in mammalia, chiefly for the attachment of the temporal muſcle.

The ſize of the temporal foſſa, depends upon the magnitude of the muſcle, which it contains. Hence it is larger in the *carnivora* than in any other order; not only occupying the whole ſides and upper part of the cranium, but being ſtill further increaſed by prominent bony *criſtæ*, growing from the frontal, parietal, and occipital bones. The two temporal muſcles are indeed ſeparated in many of theſe animals, merely by the *parietal ridge*, which would completely cover the cranium.

Theſe ridges are not ſo ſtrongly marked in any animals, as in the *carnivora:* yet they are diſcernible in moſt of the *ſimiæ.* They occur alſo in animals of the *pig kind*, and in the other *pachydermata.*

The occipital criſta is found where the others do not exiſt; as it ſerves for the attachment of the muſcles of the neck.

(D) The variations in the ſituation of the occipital foramen are important, when viewed in connection with the ordinary poſition of the animal's body. In man, who is deſigned to hold his body erect, this opening is nearly equi-diſtant from the anterior and poſterior extremities of the ſkull. The head therefore is ſupported in a ſtate of equilibrium on the vertebral column. The angle, formed by the two lines mentioned by DAUBENTON, is only of three degrees.

Quadrupeds,

Quadrupeds, which go on all-fours, have the occipital foramen and condyles ſituated farther back, in proportion as the face is elongated. That opening, inſtead of being nearly parallel to the horizon, forms a conſiderable angle with it; which, meaſured, according to DAUBENTON, is of 90 degrees in the *horſe*. The weight of the head in theſe animals, is not therefore ſuſtained by the ſpine; but by a ligament of immenſe ſtrength, which is either entirely deficient, or ſo weak, as to have its exiſtence diſputed in the human ſubject. This *ligamentum nuchæ*, or *cervical ligament*, ariſes from the ſpines of the dorſal and cervical vertebræ, (which are remarkably long for that purpoſe) and is fixed to the middle and poſterior part of the occipital bone. It is of great ſize and ſtrength in all quadrupeds, but moſt particularly in the *elephant;* where the vaſt weight of the head, ſo much increaſed by the enormous ſize of the tuſks, ſufficiently accounts for its increaſed magnitude. It is bony in the mole, probably on account of the uſe, which the animal makes of its head, in diſengaging and throwing up the earth.

Animals of the genus *ſimia* and *lemur* hold a middle rank between man, who is conſtantly erect, and quadrupeds, whoſe body is ſupported by four extremities. Their ſtructure is by no means calculated, like that of man, for the conſtant maintenance of the erect poſture; but they can ſupport it with greater facility, and for a longer time than other animals. Hence, in the *orang-outang*, the occipital foramen is only twice as far from the jaws as from the back of the head, ſo that DAUBENTON'S angle is only of 37°. It is ſomewhat larger in the other ſpecies of *ſimiæ;* and meaſures 47° in the *lemur.*

(E) The two organs, which occupy moſt of the face, are thoſe of ſmelling and taſting (including thoſe of maſtication, &c.). In proportion, as theſe parts are more developed, the ſize of the face, compared to that of the cranium, is augmented. On the contrary, when the brain is large, the volume of the cranium is increaſed in proportion to that of the face. A large cranium and ſmall face indicate therefore a large brain, with inconſiderable organs of ſmelling, taſting, maſticating, &c.; while a ſmall cranium, with a large face, ſhew that theſe proportions are reverſed.

The nature and character of each animal muſt depend conſiderably on the relative energy of its different functions. The brain is the common centre of the nervous ſyſtem. All our perceptions are conveyed to this part, as a *ſenſorium commune:* and this is the organ, by which the mind combines and compares theſe perceptions, and draws inferences from them; by which, in ſhort, it reflects and thinks. We ſhall find, that animals partake in a greater degree of this latter faculty, or at leaſt approach more nearly to it, in proportion as the maſs of medullary ſubſtance, forming their brain, exceeds

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that, which conſtitutes the reſt of the nervous ſyſem; or, in other words, in proportion as the organ of the mind exceeds thoſe of the ſenſes. Since then, the relative proportions of the cranium and face, indicate alſo thoſe of the brain, and the two principal external organs, we ſhall not be ſurprized to find, that they point out to us, in great meaſure, the general character of animals; the degree of inſtinct and docility which they poſſeſs. Man combines by far the largeſt cranium, with the ſmalleſt face; and animals deviate from theſe relations, in proportion as they increaſe in ſtupidity and ferocity.

One of the moſt ſimple methods (though ſometimes indeed inſufficient), of expreſſing the relative proportions of theſe parts, is by means of the facial line, which has been already deſcribed. This angle is moſt open, or approaches moſt nearly to a right angle in the human ſubject; it becomes conſtantly more acute, as we deſcend in the ſcale, from man; and in ſeveral birds, reptiles, and fiſhes, it is loſt altogether, as the cranium and face, are completely on a level. The idea of ſtupidity is aſſociated, even by the vulgar, with the elongation of the ſnout: hence the *crane* and *ſnipe* have become proverbial. On the contrary, when the facial line is elevated by any cauſe, which does not increaſe the capacity of the cranium, as in the *elephant* and *owl*, by the cells, which ſeparate the two tables, the animal acquires a particular air of intelligence, and gains the credit of qualities, which he does not in reality poſſeſs. Hence the latter animal has been ſelected as the emblem of the goddeſs of wiſdom The invaluable remains of Grecian art ſhew, that the ancients were well acquainted with theſe circumſtances: they were aware, that an elevated facial line formed one of the grand characters of beauty; and indicated a noble and generous nature. Hence they have extended the facial angle to 90 degrees in the repreſentation of men, on whom they wiſhed to beſtow an auguſt character. And in the repreſentations of their gods and heroes, they have even carried it beyond a right angle, and made it 100°.

It muſt, however, be allowed, that the facial angle is of chief importance in its application to the cranium of the human ſubject, and of the *quadrumana;* as various circumſtances affect the concluſions, which would reſult from employing it in other claſſes of mammalia. Thus in the *carnivorous*, and ſome of the *ruminating* animals; in the *pig*, and particularly in the *elephant*, the great ſize of the frontal ſinuſes produces an undue elevation of the facial line. In many of the *rodentia*, as the *hare*, &c., the noſe occupies ſo large a ſpace, that the cranium is thrown quite back, and preſents no point on a front view, from which this time can be drawn.

The following are the angles formed, by drawing a line along the floor of the noſtrils, and interſecting it by another, which touches the anterior margin of the upper alveoli, and the convexity of the cranium (whether the latter point be concealed by the face, or no).

European infant	90°
———— adult	85
Adult negro	70
Orang-outang	67
Long-tailed monkies	65
Baboons	40 to 30
Pole-cat	31
Pug dog	35
Maſtiff; the line paſſing along the outer ſurface of the ſkull	41
D° inner d°	30
Leopard; inner ſurface	28
Hare	30
Ram	30
Horſe	23
Porpoiſe	25

In the 3d and 4th tables of CUVIER's *Tableau Elementaire de l'Hiſtoire Naturelle*, the crania of ſeveral mammalia are repreſented in profile; ſo as to afford a ſufficient general notion of the varieties in the facial angle. A ſimilar comparative view, in one plate, is given by WHITE, in his account of the *Regular Gradation*, &c. from the work of CAMPER.

A vertical ſection of the head, in the longitudinal direction, ſhews us more completely the relative proportions of the cranium and face. In the *European*, the area of the ſection of the cranium is four times as large as that of the face; the lower jaw not being included. The proportion of the face is ſomewhat larger in the *negro:* and it increaſes again in the *orang-outang*. The area of the cranium is about double that of the face in the *monkeys:* in the *baboons*, and in moſt of the *carnivorous mammalia*, the two parts are nearly equal. The face exceeds the cranium in moſt of the other claſſes. Among the *rodentia*, the *hare* and *marmot* have it one-third larger; in the *porcupine*, and the *ruminantia*, the area of the face is about double that of the cranium; nearly triple in the *hippopotamus;* and almoſt four times as large in the *horſe*. In reptiles and fiſhes, the cranium forms a very inconſiderable portion of the ſection of the head; although it is conſiderably larger than the brain, which it contains.

The outline of the face, when viewed in ſuch a ſection, as we have juſt mentioned, forms in the human ſubject a triangle; the longeſt ſide of which is the line of junction between the cranium and face. This extends obliquely backwards and downwards, from the root of the noſe, towards the foramen occipitale. The front of the face, or the anterior line of the triangle, is the ſhorteſt of the three. The face is ſo much elongated, even in the *ſimiæ*, that the line of junction of the cranium and face is the ſhorteſt ſide of the triangle; and the anterior one the longeſt. Theſe proportions become ſtill more conſiderable in other mammalia.

(F) The want of the *os intermaxillare* has been regarded as a chief characteriſtic of the human ſubject; as one of the leading circumſtances, which diſtinguiſh man from other mammalia. That this bone is really wanting in man muſt be allowed, notwithſtanding the doubts of VICQ D'AZYR. The well-known tranſverſe ſlit, behind the alveoli of the inciſors in the human fœtus, would form a very ſlight and remote analogy between the human ſtructure, and that of animals: and, when we conſider, that the ſuperior or facial ſurface of the maxillary bones, ſo far from being marked by any ſuture, does not even bear a ſlit like that of the inferior part, it muſt be put entirely out of the queſtion.

That all other mammalia poſſeſs this bone, is not quite ſo clear, as that man has it not. The exceptions occur in the quadrumana. In addition to thoſe which the author has ſtated, it may be obſerved, that the head of an *orang-outang*, in the HUNTERIAN MUSEUM, which poſſeſſes all the other ſutures, wants thoſe, which ſeparate the intermaxillary bone: that TYSON did not find this bone in his ſpecimen of the animal, which was very young, (ſee his *Anatomy of the Pigmy*) and that it did not exiſt in a cranium, which was delineated by DAUBENTON. I have alſo ſeen the crania of other monkeys, where the other ſutures were all perfect and diſtinct, which did not poſſeſs this bone.

(G). The zygoma is wanting in the *ant-eater*;

where the temporal and molar bones have only a ſlight projection inſtead of the uſual zygomatic proceſs. This circumſtance is ſufficiently explained by the want of teeth, and the conſequent want of maſtication. The zygomatic future is ſo oblique in the *carnivora*, that the temporal bone forms the whole ſuperior margin; and the os malæ, the inferior edge of the zygoma.

The zygoma may be arched both in the vertical and horizontal directions. A curvature of the latter kind indicates the exiſtence of a ſtrong temporal muſcle; while one of the former deſcription ſhews that the maſſeter is large. Both theſe curvatures are conſiderable in the carnivora.

(H) The interval between the orbits is always ſmaller in the ſimiæ than in the human ſubject. In ſeveral of theſe, as in the monkeys, properly ſo called, the two orbits are ſeparated at their poſterior part by a ſimple bony ſeptum. In other mammalia, theſe cavities are thrown towards the ſide of the head, and to a great diſtance from each other, by the aſcending or naſal proceſſes of the upper jaw-bones, which are very large.

In thoſe mammalia, which have the orbit open at its outer and back part, ſo as to communicate with the temporal foſſa, (ſuch as the *carnivora*, *rodentia*, *edentata*, and *pachydermata*) the os malæ merely contributes to the formation of the zygoma, without being connected to the frontal or ſphenoid bones. The ſuperior maxilla merely forms the anterior border of the cavity, without conſtituting the floor of the orbit, which is indeed open below. The oſſa palati, which are large, form a conſiderable ſhare of the inner part of the cavity; the ethmoid bone not contributing to it.

The *ruminating animals*, as well as the *horſe* and *aſs*, have the margin of the orbit completed at its outer part by a bony circle, although the cavity is open behind to the temporal foſſa.

The *mole* has not, properly ſpeaking, an orbit. Its diminutive eyes, the very exiſtence of which, was for a long time queſtioned, lie under the integuments. BLUMENBACH's *Deſcription of the Bones*, in German, p. 225. note. The ſame obſervation holds good of the *myrmecophuga didactyla*. Ibid.

(I) The word *horn*, which is frequently applied in Engliſh to the *antlers* of the deer kind, as well as to the real horns of other genera, would lead to a very erroneous notion on this ſubject. The *antler* is a real *bone;* it is formed in the ſame manner, and conſiſts of the ſame elements as other bones; its ſtructure is alſo the ſame.

It adheres to the frontal bone by its baſis; and the ſubſtance of the two parts being conſolidated together, no diſtinction can be traced, when the antler is completely organized. But the ſkin of the forehead terminates at its baſis, which is marked by an irregular projecting bony circle; and there is neither ſkin nor perioſteum on the reſt of it.

The time of its remaining on the head is one year: as the period of its fall approaches, a reddiſh mark of ſeparation is obſerved between the proceſs of the frontal bone, and the antler. This becomes more and more diſtinctly marked, until the connection is entirely deſtroyed.

The ſkin of the forehead extends over the proceſs of the frontal bone, when the antler has fallen: at the period of its regeneration, a tubercle ariſes from this proceſs, and takes the form of the future antler, being ſtill covered by a prolongation of the ſkin. The ſtructure of the part at this time is ſoft and cartilaginous; it is immediately inveſted by a true perioſteum, containing large and numerous veſſels, which penetrate the cartilage in every direction, and by the gradual depoſition of oſſific matter, convert it into a perfect bone.

The veſſels paſs through openings in the projecting bony circle at the baſe of the antler: the formation of this part, proceeding in the ſame ratio with that of the reſt, theſe openings are contracted, and the veſſels are thereby preſſed, until a complete obſtruction enſues. The ſkin and perioſteum then periſh, become dry and fall off; the ſurface of the antler remaining uncovered. At the ſtated period it falls off, to be again produced, always increaſing in ſize.

(K) As the motions of the lower jaw muſt be materially influenced by the form of its condyle, and by the manner in which that proceſs is connected to the articular cavity of the temporal bone; we ſhall find, as might have been expected, a cloſe relation between theſe circumſtances, and the kind of food, by which an animal is nouriſhed. Thus the lower jaw of the carnivora can only move upwards and downwards, and is completely incapable of that horizontal motion, which conſtitutes genuine maſtication. Hence theſe animals cut and tear their food in a rude and coarſe manner, and ſwallow it in large portions, which are afterwards reduced by the ſolvent properties of the gaſtric juice. Such mammalia, on the contrary, as live on vegetables, have, in addition to this motion, a power of moving the lower jaw backwards and forwards, and to either ſide; ſo as to produce a grinding effect, which is neceſſary for bruiſing and triturating graſs, and for pulveriſing and comminuting grains. In all theſe, therefore, the form of the condyle, and of its articular cavity, allows of free motion in almoſt every direction. The teeth may be compared, in the former caſe, to ſciſſars; in the latter, to the ſtones of a mill.

(L) The teeth of the human ſubject ſeem to be deſigned for the ſingle purpoſe of maſtication; and hence an erroneous concluſion might be drawn, that they ſerve the ſame office in other animals. Many exceptions, however, muſt be made to this general rule. Some mammalia, which have teeth for the office of maſtication, have others, which can be only conſidered as weapons of offence and defence, viz. the *tuſks* of the *elephant*, *hippopotamus*, *walrus*, and *manati*. The large and long canine teeth of the *carnivora*, as the *lion*, *tiger*, *dog*, *cat*, &c. not only ſerve as natural weapons to the animal, but enable it to ſeize and hold its prey, and aſſiſt in the rude laceration which the food undergoes previous to deglutition. The *ſeal*, the *porpoiſe*, and other *cetacea*, as the *cachalot (phyſeter macrocephalus)* have all the teeth of one and the ſame form; and that obviouſly not calculated for maſtication. They can only aſſiſt in ſecuring the prey, which forms the animal's food.

(M) Animals of the genus balœna (the proper whales) have, inſtead of teeth, the peculiar ſubſtance called *whalebone*, covering the palatine ſurface of the upper jaw: this reſembles in its compoſition hair, horn, and ſuch matters.

The lower ſurface of the upper jaw forms two inclined planes, which may be compared to the roof of a houſe reverſed; but the two ſurfaces are concave. Both theſe are covered with plates of the whalebone, placed acroſs the jaws, and deſcending vertically into the mouth. They are parallel to each other, and exiſt to the number of two or three hundred on each of the ſurfaces. They are connected to the bone by the intervention of a white ligamentous ſubſtance, from which they grow;

but their oppoſite edge, which is turned towards the cavity of the mouth, has its texture looſened into a kind of fringe, compoſed of long and ſlender fibres of the horny ſubſtance; which therefore covers the whole ſurface of the jaw. This ſtructure probably ſerves the animal in retaining and confining the *molluſca*, which conſtitute its food.

The teeth of the *ornithorhynchus paradoxus* and *hyſtrix* deviate very conſiderably from thoſe of other mammalia. In the former animal there is one on each ſide of the two jaws: it is oblong, flattened on its ſurface, and conſiſts of a horny ſubſtance adhering to the gum. There are likewiſe two horny proceſſes on the back of the tongue: theſe point forwards, and are ſuppoſed by Mr. Home to prevent the food from paſſing into the fauces, before it has been ſufficiently maſticated. In the *o. hyſtrix*, there are ſix tranſverſe rows of pointed horny proceſſes at the back of the palate; and about twenty ſimilar horny teeth on the correſponding part of the tongue.

Mr. HOME in the *Philoſ. Tranſ.* 1800, part 2. 1802, parts 1 and 2.

(N) The ſubſtance compoſing theſe tuſks, and commonly called ivory, is certainly different from the bone of other teeth. It is, generally ſpeaking, more hard and compact in its texture. The ivory of the elephant's tuſk is diſtinguiſhed from all others by the curved lines, which paſs in different directions from the centre of the tooth, and form by their decuſſation, a very regular arrangement of curvilinear lozenges. It ſoon turns yellow from expoſure to the air. The tuſk of the hippopotamus is harder and whiter; and conſequently preferred for the formation of artificial teeth. In the walrus, the interior of the tooth is compoſed of ſmall round portions, placed irregularly in a ſubſtance of different appearance, like the pebbles in the pudding ſtone; and the molar teeth have a ſimilar ſtructure.

(O) The facts, which the author has here recounted, have been ſome times brought forwards in order to prove the vaſcularity of the teeth; a doctrine, which is refuted by every circumſtance in the formation, ſtructure, and diſeaſes of theſe organs. It may be firſt obſerved, that the appearances exhibited by the teeth in queſtion, are by no means what we ſhould reaſonably expect in ſuch a caſe. When a bullet has entered the ſubſtance of the body, the ſurrounding lacerated and contuſed parts do not grow to the metal, and become firmly attached to its ſurface, but they inflame and ſuppurate in order to get rid of the offending master. If the ivory be vaſcular and ſenſible, why do not the ſame proceſſes take place in it?

We can explain very ſatisfactorily how a bullet may enter the tuſk of an elephant, and become

imbedded

imbedded in the ivory without any opening for its admiſſion being perceptible. It will be ſhewn in a ſubſequent note, that theſe tuſks are conſtantly growing during the animal's life, by a depoſition of ſucceſſive laminæ within the cavity, while the outer ſurface and the point are gradually worn away: and that the cavity is filled for this purpoſe with a vaſcular pulp, ſimilar to that, on which teeth are originally formed. If a ball penetrate the ſide of a tuſk, croſs it cavity, and lodge in the ſlighteſt way on the oppoſite ſide, it will become covered towards the cavity by the newly depoſited layers of ivory, while no opening will exiſt between it and the ſurface, to account for its entrance. If it have only ſufficient force to enter, it will probably ſink, by its own weight, between the pulp and tooth, until it reſts at the bottom of the cavity. It there becomes ſurrounded by new layers of ivory; and as the tuſk is gradually worn away, and ſupplied by new depoſitions, it will ſoon be found in the centre of the ſolid part of the tooth. Laſtly, a foreign body may enter the tuſk from above, as the plate of bone, which forms its ſocket is thin; if this deſcends to the lower part of the cavity, it may become imbedded by the ſubſequent formations of ivory. This muſt have happened in a caſe where a ſpear-head was found in an elephant's tooth. The long axis of the foreign body correſponded to that of the cavity. No opening for its admiſſion could be diſcovered, and it is very clear, that no human ſtrength could drive ſuch a body through the ſide of a tuſk. *Philoſ. Tranſ.* 1801. part 1.

(P) The *front teeth* are the *inciſores*, or *cutting-teeth;* the *primores* of Linnæus. The *corner teeth* are the *canini; laniarii* of Linnæus; *cuſpidati* of Mr. Hunter. The *back teeth* are the Molares or grinders. The term of *tuſks* is applied to ſuch teeth as extend out of the cavity of the mouth.

(Q) The ſtructure of the inciſor teeth, in the rodentia, deſerves attention on ſeveral accounts. They are covered by enamel only on their anterior or convex ſurface, and the ſame circumſtance holds good with reſpect to the tuſks of the hippopotamus. Hence as the bone wears down much faſter than this harder covering, the end of the tooth always conſtitutes a ſharp cutting edge, which renders it very deſerving of the name of an inciſor tooth.

This partial covering of enamel refutes, as Blake has obſerved *(Eſſay on the Structure, &c. of the Teeth*, p. 212*)*, the opinion that the enamel is formed by the proceſs of cryſtallization.

The inciſor teeth of theſe animals are uſed in cutting and gnawing the harder vegetable ſubſtances; for which their above-mentioned ſharp edge renders them particularly well adapted. Hence Cuvier has arranged theſe animals in a particular order by the name of *rodentia*, or the gnawers. As this employment ſubjects the teeth to immenſe friction, and mechanical attrition, they wear away very rapidly, and would ſoon be conſumed, if they did not poſſeſs a power of growth, by which this loſs is recompenced.

Theſe teeth, which are very deeply imbedded in the jaw, are hollow internally, juſt like a human tooth, which is not yet completely formed. Their cavity is filled with a vaſcular pulp, ſimilar to that on which the bone of a tooth is formed; this makes a conſtant addition of new ſubſtance on the interior of the tooth, which advances to ſupply the part worn down. The covering of enamel extends over that part of the tooth, which is contained in the jaw, as we might naturally expect; for this muſt be protruded at ſome future period to ſupply the loſs of the anterior portion. Although theſe teeth are very deeply implanted in the maxillary bones, they can hardly be ſaid to poſſeſs a fang or root; for the form of the part is the ſame throughout; the covering of enamel is likewiſe continued; and that part, which at one period is contained in the jaw, and would form the fang, is afterwards protruded to conſtitute the body of the tooth.

The conſtant growth of theſe teeth therefore proceeds in the ſame manner, and is effected on the ſame principles as the original formation of any tooth ; and can by no means furniſh an argument for the exiſtence of veſſels in the ſubſtance of the part.

We cannot help being ſtruck with the great ſize of theſe teeth, compared with the others of the ſame animal, or even with the bulk of the animal. Their length in the lower jaw nearly equals that of the jaw itſelf, albough a ſmall proportion only of this length appears through the gum. They repreſent the ſegment of a circle; and are contained in a canal of the bone, which deſcends under the ſockets of the grinders, and then mounts up, in ſome inſtances, to the root of the coronoid proceſs: hence although their anterior cutting edge is in the front of the mouth, the poſterior extremity is behind all the grinding teeth. No animal exhibits this ſtructure better than the rat. The beaver alſo affords a good ſpecimen of it on a larger ſcale. It has been drawn in this animal by BLAKE, *(Eſſay on the Structure, &c. of the Teeth,* tab. 9. fig. 3.*)* The tooth does not extend ſo far in the upper jaw; it is there implanted in the intermaxillary bone, and terminates over the firſt grinder.

The obſervations which have been made reſpecting the conſtant growth of the inciſor teeth of the *glires*, will apply alſo to the tuſks of the *elephant.* Theſe are hollow internally, through the greater part of their length, and the cavity contains a vaſcular pulp, which makes conſtant additions of ſucceſſive layers, as the tuſk is worn down. One of the elephants at Exeter Change is ſaid to have nearly bled to death from a fracture of the tuſk, and conſequent laceration of the veſſels of the pulp. The tuſks of the *hippopotamus*, and probably all other teeth of this deſcription grow in the ſame manner. Farther and more accurate obſervation may hereafter ſhew, that the ſame mode of growth obtains alſo in other claſſes of teeth, when they are expoſed to great friction. Something ſimilar may certainly be obſerved in the grinders of the horſe. The tooth is not finiſhed when it cuts the gum: the lower part of its body is completed while the upper part is being worn away in maſtication; and the proper fang is not added till long after. Hence we can never get one of theſe teeth in a perfect ſtate, for if the part out of the gum is complete, the reſt of the body is imperfect; and there are no fangs: on the contrary, when the fangs are formed, much of the body has been worn away in maſtication. BLAKE alſo aſſerts that this ſtructure is found in the grinders of the *beaver*, p. 99. tab. 9. fig. 4.

(R) This animal is found ſo conſtantly with only one tuſk, that it has been called in common language, the *ſea-unicorn;* and LINNÆUS has even given it a ſimilar appellation, that of *monodon*. Yet there can be no doubt that it poſſeſſes originally two of theſe; one in either jaw bone: and that which is wanting, muſt have been loſt by ſome accidental circumſtanc, as we can eaſily ſuppoſe, (SHAW's *Zoology*, vol. ii. p. 473.) Theſe tuſks often equal in length that of the animal's body; which may be 18 feet or more: yet they are always ſlender.

(S) The diſtribution of the enamel, and bony ſubſtance, varies in the teeth of different animals, aud even in the different orders of teeth in the ſame animal.

All the teeth of the *carnivora*, and the inciſors of the *ruminating animals*, have the crown only covered with enamel, as in the human ſubject. The immenſe foſſil grinders of the *animal incognitum* or *mammoth* have a ſimilar diſtribution of this ſubſtance.

The grinders of graminivorous quadrupeds, and the inciſors alſo of the horſe have proceſſes of enamel, deſcending into the ſubſtance of the tooth. Theſe organs have alſo in the laſt-mentioned animals a third component part, differing in appearance from both the others, but reſembling the bone more than the enamel. BLAKE has diſtinguiſhed this by the name of *cruſta petroſa*; and CUVIER calls it *cement*.

The phyſiological explanation of this difference in ſtructure is a very eaſy and clear one. The food of the *carnivora* requires very little comminution before it enters the ſtomach: hence the form of their grinding teeth is by no means calculated for grinding; and as the articulation of the jaw admits no lateral motion, the molares, of which the lower are overlapped by the upper, can only act like the inciſors of other animals. The food of graminivorous quadrupeds is ſubject to a long proceſs of maſtication, before it is expoſed to the action of the ſtomach. The teeth of the animals ſuffer great attrition during this time, and would be worn down very rapidly but for the enamel, which is intermixed with their ſubſtance. As this part is harder than the other conſtituents of the teeth, it reſiſts the attrition longer, and preſents the appearance of prominent ridges on the worn ſurface, by which the grinding of the food is much facilitated.

The diſtinction of the three ſubſtances is ſeen better in the tooth of the elephant than in any animal. The beſt method of diſplaying it is by making a longitudinal vertical ſection, and poliſhing the cut ſurface. The *cruſta petroſa* will then be diſtinguiſhed by a greater yellowneſs and opacity in its colour; and by an uniformity in its appearance, as no laminæ or fibres can be diſtinguiſhed.

The pulp of a grinding tooth of a graminivorous quadruped is divided into certain conical proceſſes, which are united at their baſes. Theſe vary from two to ſix in the *horſe* and *cow*. On theſe the bone of the tooth is formed, as on the ſingle pulp of the human ſubject, but it is here divided into as many ſeparate ſhells, as there are proceſſes of the pulp: all of them however incloſed in a common capſule. The oſſification commences, as in all teeth, on the points of the pulp, and extends towards the baſis: when it has arrived there, the ſhells unite together; and they alſo join at their outer margins. Between the proceſſes of the pulp other productions deſcend from the capſule in a contrary direction; and depoſit, on the ſurface of the ſhells, enamel diſtinguiſhable by its cryſtalline appearance, and hence denominated by BLAKE *cortex ſtriatus.* When theſe membranous productions have formed their portions of enamel, they ſecrete the *cruſta petroſa* within the cavities left between theſe productions of enamel. The outer ſurface of the bone of the tooth is covered by enamel, which may be compared to that which inveſts the crown of a human tooth, except that it is depoſited in an irregular waving line, in order to render the ſurface better calculated for grinding: and the inequalities of this ſurface of enamel are filled up by cruſta petroſa. The exterior enamel, and cruſta petroſa, (which may be ſo named, by way of diſtinguiſhing them from the proceſſes within the tooth), are formed by the ſurface of the capſule.

If then we make a tranſverſe ſection of a grinding tooth of the *horſe* or *cow*, the exterior ſurface will be found to conſiſt of an irregular layer of *cruſta petroſa:* this is ſucceeded by a waving line of *enamel*, within which is the proper *bone of the tooth.* But the ſubſtance of the latter is penetrated by two productions of enamel ; in the interior of each of which is *cruſta petroſa.*

The cruſta petroſa which fills theſe internal productions of enamel, is ſometimes not completely depoſited before the tooth cuts the gum: hence cavities are left in the centre of the tooth, which become filled with a dark ſubſtance compoſed of the animal's food, and other foreign matters. This ſeldom happen to any conſiderable extent in the grinders of the *horſe.* In the *cow* and *ſheep* theſe cavities are conſtantly filled with the dark adventitious matter; the cruſta petroſa being confined to the exterior ſurface of the tooth, and not exiſting even there ſo plentifully as in the horſe.

The lower grinders of the horſe differ very much in their formation from thoſe of the upper-jaw. Oſſification commences in theſe by four or five points, which increaſe into as many ſmall ſhells; yet they unite without any proceſſes of the capſule paſſing down between to form internal productions of the enamel. This ſubſtance is however depoſited in a very convoluted manner on the bone of the tooth, ſo that the ſame end is attained, as if productions of the cortex ſtriatus had exiſted in the centre of the part. The cruſta petroſa fills up the irregularities of this waving line of enamel. An horizontal ſection of ſuch a tooth preſents the three ſubſtances arranged within each other: the cruſta petroſa is external; then comes the enamel, which includes nothing but the proper bone of the tooth.

The inciſors of the horſe have a production of enamel in their centre; but the cavity, which this forms, containing no cruſta petroſa, is merely filled by the particles of food, &c. As theſe proceſſes of enamel deſcend only to a certain extent in the tooth, they diſappear at laſt from the conſtant wear of the part in maſtication. This is improperly called the filling up of the teeth; and hence a criterion ariſes of the horſe's age.

The grinding teeth of the elephant contain the moſt complete intermixture of the three ſubſtances; and have a greater proportion of *cruſta petroſa*, than thoſe of any other animal. The pulp forms a number of broad flat proceſſes, lying parallel to each other, and placed tranſverſely between the inner and outer laminæ of the alveoli. The bone of the tooth is formed on theſe in ſeparate ſhells, commencing at their looſe extremities, and extending towards the baſis, where they are connected together. The capſule ſends an equal number of membranous productions; which firſt cover the bony ſhells with *enamel*, and then inveſts them with *cruſta petroſa;* which latter ſubſtance unites and conſolidates the different portions. The bony ſhells vary in number from four to twenty-three, according to the ſize of the tooth, and the age of the animal: they have been deſcribed under the term of denticuli, and have been repreſented as ſeparate teeth in the firſt inſtance. It muſt however be remembered that they are formed on proceſſes of one ſingle pulp.

When the *cruſta petroſa* is completely depoſited, the different denticuli are conſolidated together. The bony ſhells are united at their baſe to the neighbouring ones; the inveſtments of enamel are joined in like manner: and the intervals are filled with the third ſubſtance, which really deſerves the name beſtowed on it by CUVIER, of *cement*. The pulp is then elongated for the purpoſe of forming the roots or fangs of the tooth. From the peculiar mode of dentition of this animal, which will be explained in a ſubſequent note, the front portion of the tooth has cut the gum, and is employed in maſtication, before the back part is completely formed, even before ſome of the poſterior denticuli have been conſolidated. The back of the tooth does not appear in the mouth until the anterior part has been worn down even to the fang.

A horizontal ſection of the elephant's tooth preſents a ſeries of narrow bands of bone of the tooth, ſurrounded by correſponding portions of enamel. Between theſe are portions of cruſta petroſa; and the whole circumference of the ſection is compoſed of a thick layer of the ſame ſubſtance.

A vertical ſection in the longitudinal direction exhibits the proceſſes of bone, upon the different denticuli, running up from the fangs; a vertical layer of enamel is placed before, and another behind each of theſe. If the tooth is not yet worn by maſtication, the two layers of enamel are continuous at the part, where the bone terminates in a point; and the front layer of one denticulus is continuous with the back layer of the ſucceeding one, at the root of the tooth; ſo that the enamel, aſcending on the anterior, and deſcending on the poſterior ſurface of each denticulus, forms a continued line through the whole tooth. Cruſta petroſa intervenes between the aſcending and deſcending portions of the enamel.

As the ſurface of the tooth is worn down in maſtication, the proceſſes of enamel, reſiſting by their ſuperior hardneſs, form prominent ridges on the grinding ſurface; which muſt adapt it excellently for bruiſing and comminuting any hard ſubſtance.

The grinding baſes, when worn ſufficiently to expoſe the enamel, preſent a very different appearance in the *Aſiatic* and *African* elephants. The proceſſes of enamel, in the former ſpecies, repreſent flattened ovals, placed acroſs the tooth. In the latter, they form a ſeries of lozenges, which touch each other in the middle of the tooth.

It does not appear, that *cruſta petroſa* is an eſſential part in the grinders of graminivorous animals. For thoſe of the *rhinoceros* do not poſſeſs it, although the enamel deſcends into their ſubſtance, and forms a cavity, which is filled with the food, &c.

HOME and BLAKE likewiſe ſtate, that it does not exiſt in the *hippopotamus*, where there are internal productions of enamel: but Mr. MACARTNEY, the learned and ingenious lecturer on comparative anatomy at St. Bartholomew's Hoſpital, has found it in ſmall quantity on the exterior ſurface of the tooth, near its root.

Mr. CORSE's *Obſervations on the different Species of Aſiatic Elephants.* Philoſ. Tranſ. 1799, part 2.

Some Obſervations on the Teeth of graminivorous Quadrupeds, by E. HOME, Eſq. Ibid. With Delineations of the Teeth of the *Elephant*, *Horſe*, *Cow*, *Sheep*, *Hippopotamus*, and *Rhinoceros*.

BLAKE's *Eſſay on the Structure and Formation of the Teeth in Man, and various Animals,* with plates.

TENON *ſur une Methode particuliere d'etudier l'Anatomie*, in the *Memoires de l'Inſtitut National*, tome 1, an. 6.

CUVIER, *Léçons d'Anatomie comparée*, tome 3.

(T) All the three kinds of teeth are found in the *quadrumana*, the *carnivora*, the *pachydermata* (excepting the *two horned rhinoceros* and *elephant)*, the *horſe*, and thoſe *ruminating animals*, which have no horns.

CUVIER ſtates, that the teeth of an animal, whoſe bones are found in a foſſile ſtate, reſemble thoſe of man, in being arranged in a continued and unbroken ſeries.

In the *ſimiæ*, *carnivora*, and all ſuch as have canines longer than the other teeth, there is at leaſt one vacancy in each jaw, for lodging the *cuſpidatus* of the oppoſite jaw. There is a vacancy behind each canine in the *bear*.

The horned ruminating animals not only want entirely the *upper inciſors*, but they are alſo deſtitute of *cuſpidati*, except the *ſtag*, which has rudiments of theſe teeth; and the muſk (*moſchus moſchifer*) where they are very long, and curved in the upper jaw.

Between the inciſors and grinders of the *horſe*, a very large vacancy is left, in the middle of which a ſmall *canine tooth*, termed the *tuſh*, is found in the male animal; but very rarely in the female.

The elephant has *grinders* and two *tuſks* in the upper jaw; but the former only in the lower. The immenſe tuſks belong properly to the male animal: as they are ſo ſmall in the female, generally ſpeaking, as not to paſs the margin of the lip. (Corse in *Phil. Tranſ.* 1799, part 2. p. 208.)

The *ſloths* have grinding and canine teeth, without inciſors. The *dolphin* and *porpoiſe* have ſmall conical teeth, all of one ſize and ſhape, arranged in a continued line throughout the alveolar margin of both jaws. The *cachalot* (*Phyſeter macrocephalus*) has theſe in the lower jaw only. The teeth of the *ſeal* are all of one form, viz. that of the canine kind; conical and pointed.

The *narwhal* has no other teeth than the two long tuſks implanted in its os intermaxillare; of which one is ſo frequently wanting. A head, in which there are two of theſe tuſks, is delineated by Dr. SHAW, in his Zoology, from a ſpecimen in the Leverian Muſeum. Theſe tuſks are remarkable for the ſpirally convoluted appearance of their external ſurface. They are hollow internally, and probably have a conſtant growth like the elephant's tuſks.

(U) The permanent teeth are generally formed in cavities near the roots of the temporary ones; and they ſucceed to the vacancies left by the diſcharge of the latter.

A different mode of ſucceſſion obtains, however, in ſome inſtances. The adult molares of the human ſubject are not formed near any of the temporary teeth; but in the back of the two jaws; from which ſituation they advance ſucceſſively towards the front, in proportion as the maxillary bones are lengthened in that direction. A ſimilar, but much more remarkable ſpecies of ſucceſſion is obſerved in the *grinders* of the *elephant*, where it was aſcertained by the labours of Mr. CORSE, who has explained and illuſtrated the ſubject, in a ſeries of beautiful engravings. See *Obſervations on the different Species of Aſiatic Elephants, and their Mode of Dentition.* Phil. Tranſ. 1799, part 2.

We never ſee more than one grinder, and part of another, through the gum in this animal. The anterior one is gradually worn away by maſtication; its fangs and alveolus are then abſorbed: the poſterior tooth coming forwards to ſupply its place. As this goes through the ſame ſtages as the preceding grinder ; a third tooth, which was contained in the back of the jaw, appears through the gum, and advances, in proportion as the deſtruction and abſorption of the other proceed. The ſame proceſs is repeated at leaſt eight times ; and each new grinder is larger than that which came before it. The 1ſt, or milk grinder, is compoſed of four tranſverſe plates or denticuli, and cuts the gum ſoon after birth. The 2d, which has eight or nine plates, has completely appeared at the age of two years. The 3d, formed of twelve or thirteen, at ſix years. From the 4th to the 8th grinder, the number of plates varies from fifteen to twenty-three, which is the largeſt hitherto aſcertained. The exact age at which each of theſe is completed, has not yet been made out. But it appears, that every new one takes at leaſt a year more for its formation than its predeceſſor.

From the gradual manner, in which the tooth advances, it is manifeſt, that a ſmall portion of it only can penetrate the gum at once. A grinder, conſiſting of twelve or fourteen plates, has two or three of theſe through the gum, whilſt the others are imbedded in the jaw. The formation of the tooth is complete therefore, firſt, at its anterior part, which is employed in maſtication, while the back part is very incomplete ; as the ſucceeding laminæ advance through the gum, their formation is ſucceſſively perfected. But the poſterior layers of the tooth are not employed in maſtication, until the anterior ones have been worn down to the very fang, which begins to be abſorbed. One of theſe grinders can never therefore be procured in a perfect ſtate: for if its anterior part has not been at all worn, the back is not completely formed, and the fangs in particular are wanting; while the ſtructure of the back of the tooth is not completed, until the anterior portion has diſappeared.

A ſimilar kind of ſucceſſion, but to a leſs extent, has been aſcertained by Mr. HOME, in the teeth of the *ſus Æthiopicus.*

Obſervations on the Structure of the Teeth of Graminivorous Quadrupeds; particularly thoſe of the Elephant, and ſus Æthiopicus. Phil. Tranſ. 1799, part 2.

The reſearches of the ſame gentleman have alſo proved it to exiſt in the *wild boar* to a certain degree; and have rendered it probable, that it occurred likewiſe in the *animal incognitum* (*mammoth*).

Obſervations on the Structure and Mode of Growth of the Wild Boar, and Animal Incognitum. Phil. Tranſ. 1801, part 2.

(V) The numbers of cervical vertebræ is the ſame in the *cetacea*, as in other mammalia, according to CUVIER; but ſome of them are anchyloſed. Thus the two firſt are united in the *dolphin* and *porpoiſe*; and the ſix laſt in the genus *phyſeter*. *Léçons d'Anat. Comp.* tome 1, p. 154.

It muſt be accounted a ſingular circumſtance, that the number of cervical vertebræ ſhould be ſo conſtantly the ſame in animals, whoſe neck differs ſo much in length; when the number of pieces in the other regions of the ſpine, varies greatly in the different genera. No inſtance has, I believe, been recorded, in which more than ſeven cervical vertebræ have been found in the human ſubject; although the number of thoſe in the back and loins ſometimes deviates from the natural ſtandard.

(W) Theſe proceſſes, which are particularly conſpicuous in ſuch carnivorous animals, as have great ſtrength in their neck, afford attachment to the large and powerful muſcles, by which the animal executes thoſe ſtrong and rapid motions of the head, which are neceſſary in attacking its prey, or defending itſelf. The *badger*, in this country, affords an excellent ſpecimen of the ſtructure alluded to.

The *mole* and *ſhrew* have no ſpinous proceſſes in the neck. The vertebræ form ſimple rings, with conſiderable motion on each other. Theſe proceſſes are either very ſhort, or altogether deficient in the long necked animals; as the *horſe*, *camel*, *giraffe*, &c. They would otherwiſe afford an obſtacle to the bending of the neck backwards.

The ſix laſt vertebræ of the neck are anchyloſed in the *ant-eater* and *manis*.

(X) Moſt of the *ſimiæ*, and even ſome, which very much reſemble the human ſubject, as the *orang-outang*, which CAMPER diſſected, *(ſimia pygmæus)*, have the ſacrum formed of three pieces; which conſequently leave only two pair of openings for the paſſage of the nerves. Now, as GALEN mentions theſe circumſtances of the human ſacrum, in his work on the bones, it muſt appear very clearly that the deſcription could not have been taken from the human ſubject; but was probably derived, as VESALIUS ſuppoſed, from the *ape;* although SILVIUS and EUSTACHIUS have endeavoured to invalidate this concluſion. See VESAL. *Epiſt. de rad. Chynæ;* alſo his great work, *De Corp. hum. Fabricâ*, p. 99.

The true orang-outang *(ſimia ſatyrus)* has a ſacrum compoſed of five pieces. The *elephant* has alſo five. See BLAIR *Oſteogr. Elephantina*, p. 29.

(Y) In *monkeys*, and even in ſuch *ſimiæ* as have no tails, where the os coccygis conſiſts at moſt of three pieces only; this bone is perforated by a continuation of the vertebral canal, and by openings for the tranſmiſſion of nerves. This ſtructure is aſcribed by GALEN to the human coccyx; and hence VESALIUS has derived another argument, to ſhew that GALEN'S Oſteology was not drawn from the human ſkeleton.

The *orang-outang*, like man, has a coccyx compoſed of five pieces, not perforated. TYSON'S *Anat. of a Pigmy*, p. 69.

Thoſe vertebræ of the tail of mammalia, which are neareſt to the ſacrum, are perforated by a continuation of the canal for the medulla ſpinalis. The lower ones are ſolid. The want of pelvis renders it impoſſible for us to decide the number of ſacral and coccygeal vertebræ in the cetacea: but the whole number of pieces in the ſpine of the *dolphin* and *porpoiſe* is 66.

(Z) Oſſification of the cartilage, which connects the two oſſa pubis, is ſo rare in the human ſubject, that one caſe only of complete anchyloſis of theſe bones has been hitherto recorded: (SOEMMERRING *de Corp. human. Fab.* tom. 1. p. 22. note ***) although ſeveral inſtances of partial bony union have been obſerved. See SANDIFORT, *Obſ. Anat. Pathol*, vol. 2.; WYNPRESSE *de Ancyloſi*; and MICHELL *de Synchondrotomia pubis*. Amſtelod. 1783. Such an occurrence is not, however, very rare in the horſe.

(A a) The *onithorhynchus paradoxus* and *hiſtrix* have ribs of a very ſingular ſtructure. Their true ribs, which are ſix in number, conſiſt of two pieces of bone; a longer one joined to the ſpine, and a ſhorter connected to the ſternum. Theſe are united by means of a piece of cartilage; ſo as to conſtitute a ſtructure, approaching to that of birds. The falſe ribs, ten in number, terminate anteriorly in broad, flattened, oval bony plates, connected together by elaſtic ligaments. *Phil. Tranſ.* 1802, part 1, plate 3.

(B b) This proceſs may be compared to the keel-like projection of the ſternum of birds. It ſerves for the origin of thoſe ſtrong muſcles of the anterior extremity, which aſſiſt the animal in digging its way under ground.

(C c) We may aſſert, as a general obſervation, that the four component parts of the upper extremity, viz. the ſhoulder, arm, fore-arm, and hand, can be clearly ſhewn to exiſt in the anterior extremities of all mammalia; however diſſimilar they may appear to each other on a ſuperficial inſpection, and however widely they may ſeem to deviate from the human ſtructure.

Whenever an animal of one claſs reſembles thoſe of a different order in the form and uſe of any part, we may be aſſured, that this reſemblance is only in externals; and that it does not affect the number and arrangement of the bones. Thus the *bat* has a kind of wings; but an attentive examination will prove, that theſe are really hands, with the phalanges of the fingers elongated. The *dolphin*, *porpoiſe*, and other *cetacea*, ſeem to poſſeſs fins, conſiſting of a ſingle piece. But we find under the integuments of the fin-like members, all the bones of an anterior extremity, flattened in their form, and hardly ſuſceptible of any motion on each other. We can recognize very clearly the ſcapula, humerus, bones of the fore-arm, and a hand conſiſting of five fingers: the ſame parts, in ſhort, which form the anterior extremity of other mammalia. See TYSON's *Anatomy of a Porpoiſe*, fig. 10 and 11.: alſo BLASII *Anatomia Animalium*, tab. 51, fig. 3, 4.

The fore-feet of the *ſea-otter*, *ſeal*, *walrus*, and *manati*, form the connecting link between the anterior extremities of other mammalia, and the pectoral fins of the whale kind. The bones are ſo covered and connected by integuments, as to conſtitute a part, adapted for the purpoſes of ſwimming: but they are much more developed than in the latter animals, and have free motion on each other.

The cold-blooded quadrupeds bear great analogy in the four component parts, and in the general ſtructure of their anterior extremities, to the warm-blooded ones. See CALDESI's *Obſervations on the Turtle*, tab. 3. fig. 1. 4, 5.

The bones of the wing of birds have a conſiderable and unexpected reſemblance to thoſe of the fore-feet of the mammalia. And the fin-like anterior member of the penguin contains, within the integuments, the ſame bones as the wings of other birds.

(D d) The clavicle ſupports the anterior extremity, and maintains the ſhoulder at its proper diſtance from the front of the trunk. It exiſts, therefore, in all ſuch animals as make much uſe of theſe members, whether for the purpoſe of climbing, digging, ſwimming, or flying. It does not exiſt, on the contrary, in ſuch as uſe their fore-feet merely for the purpoſe of progreſſion; ſince theſe limbs muſt be brought more forwards on the cheſt, that they may ſupport that part, by being placed perpendicularly under it. In the genera, which hold an intermediate rank between theſe; which do not enjoy ſuch an extenſive utility of the fore-feet as the firſt diviſion of animals; and are not ſo limited in their employment as the ſecond, the *clavicular bones*, or imperfect clavicles exiſt.

(E e) The humerus becomes ſhorter, in proportion as the metacarpus is elongated; ſo that in animals, which have what is called a cannon bone, the os humeri hardly extends beyond the trunk. Hence the miſtakes, which are made in common language, by calling the *carpus* of the horſe his fore-knee, &c.

The radius forms the chief bone of the fore-arm in the mammalia, generally ſpeaking; the ulna is a ſmall ſlender bone, terminating ſhort of the wriſt in a point, and often conſolidated with the radius, as in the *horſe* and *ruminating animals*. A few genera, which have great and free uſe of their anterior extremity, have the power of pronation and ſupination. But this power diminiſhes, as the fore-feet are uſed more for the purpoſe of ſupporting the body in ſtanding, and in progreſſion. In this caſe, indeed, the extremity may be ſaid to be conſtantly in the prone poſition, as the back of the carpus and toes is turned forwards.

The lower end of the ulna is larger than that of the radius in the elephant; but this circumſtance occurs in no other inſtance.

The radius and ulna exiſt in the *ſeal*, *manati*, and *whales*, but in a flattened form.

Several genera of mammalia poſſeſs a hand; but it is much leſs complete, and conſequently leſs uſeful than that of the human ſubject, which well deſerves the name beſtowed on it by Ariſtotle, of the *organ of all organs*. The great ſuperiority of that moſt perfect inſtrument, the human hand, ariſes from the ſize and ſtrength of the thumb, which can be brought into a ſtate of oppoſition to the fingers, and is hence of the greateſt uſe in graſping ſpherical bodies, in taking up any object in the hand, in giving us a firm hold on whatever we ſeize; in ſhort, in a thouſand offices, which occur every moment of our lives, and which either could not be accompliſhed at all, if the thumb were abſent, or would require the concurrence of both hands, inſtead of being done by one only. Hence it has been juſtly deſcribed by ALBINUS as a ſecond hand "*manus parva majori adjutrix*," *de ſceleto*, p. 465.

All the *ſimiæ* poſſeſs hands: but even in thoſe, which may be moſt juſtly ſtiled *anthropomorphous*, the thumb is ſmall, ſhort, and weak; and the other fingers elongated and ſlender. In others, as ſome of the *cercopitheci*, there is no thumb, or at leaſt it is concealed under the integuments; but theſe animals have a kind of fore paw, which is of ſome uſe in ſeizing and carrying their food to the mouth, in climbing, &c. like that of the *ſquirrel*. The genus lemer has alſo a ſeparate thumb. Other animals, which have fingers ſufficiently long and moveable for ſeizing and graſping objects, are obliged, by the want of a ſeparate thumb, to hold them by means of the two fore-paws; as the ſquirrel, rat, opoſſum, &c. Thoſe, which are moreover obliged to reſt their body on the fore-feet, as the *dog* and *cat*, can only hold objects by fixing them between the paw and the ground. Laſtly, ſuch as have the fingers united by the integuments, or encloſed in hoofs, loſe all power of prehenſion.

The *ſimiæ* in general have nine bones in the carpus. RIOLANI *Anthropographia and Oſteolog.* p. 908. Paris, 1626; but there are only eight in the *orang-outang*, according to TYSON. There are five carpal bones in the fin of the whale, of a flattened form, and hexagonal.

The metacarpus is elongated in thoſe animals, where the toe only touches the ground in ſtanding or walking; and conſtitutes the part, which is commonly called the fore-leg; as the carpus is termed the knee.

The number of metacarpal bones is the ſame with that of the fingers or fore-toes: except in the ruminating animals. Even in theſe, as the author obſerves, there are two diſtinct metacarpal bones, lying cloſe together before birth; the oppoſed ſurfaces firſt become thinner, then are perforated by ſeveral openings, and at laſt diſappear; ſo that the adult animal has a ſingle cannon bone, poſſeſſing a common medullary cavity internally, and marked on the outſide with a ſlight groove at the place of the original ſeparation. There is therefore but one metacarpal bone in the adult for the two toes. The ſtructure of the metatarſus is the ſame.

In the *horſe* on the contrary, if we allow the *ſplint bones* to belong to the metacarpus, there will be three to a ſingle toe. DAUBENTON conſiders the common bone of this animal as ſupplying the place of the three metacarpal bones of man: he compares the outer ſplint bone to the metacarpal of the little finger, and the inner to that of the thumb. STUBBS views the cannon as the metacarpal of the middle and ring fingers; and the inner ſplint, as that of the fore-finger. BUFFON *Hiſt. Naturelle*, 4to. ed. p. 362. vol. 4. STUBBS's *Anatomy of the Horſe.*

The ſingle finger or fore-toe of the horſe is compoſed of the uſual three phalanges; the firſt, which is articulated to the cannon, is called the *paſtern;* the 2d is the *coronet;* and the 3d the *os baſis* or *coffin bone;* on which the hoof reſts. There are alſo two ſeſamoid bones at the back of the paſtern joint: and an additional part called the *ſhuttle-bone* connected to the coffin.

In thoſe animals, which have five toes, as the carnivora, &c., that which lies on the radial ſide of the extremity, and is therefore analogous to the thumb, is parallel with the others; and the animal conſequently has not the power of graſping any object. The laſt phalanx in theſe ſupports the nail of the animal; and ſends a proceſs into its cavity. Theſe parts are ſo connected that the nail is naturally turned upwards, and not towards the ground; ſo that its point is not injured in the motions of the animal. The phalanx muſt be bent in order to point the nail forwards or downwards.

The order of *rodentia* have generally five toes: that which correſponds to the thumb being the ſhorteſt.

The *elephant* has five complete toes; but they are almoſt concealed by the thick ſkin.

The *pig* has four toes; two larger ones, which touch the ground; and two ſmaller behind theſe, which do not reach ſo far. There is alſo a bone, which ſeems to be the rudiment of a thumb.

The phalanges of the *cetacea* are flattened; not moveable, and joined together in the fin.

(F f) The length of the femur depends on that of the metatarſus; and it bears an inverſe ratio to the length of that part.

Hence it is very ſhort in the *horſe*, *cow*, &c. where the ſame miſtakes are commonly committed in naming the parts, as in the anterior extremity.

The proportions of the thigh and leg vary in different animals. The latter part exceeds the former in the human ſubject; and the ſame remark may be made reſpecting the arm and fore-arm. Theſe parts are nearly of the ſame length in the *orang-outang*. Some perſons have affirmed that the Negro forms a connecting link between the European and the orang-outang in theſe reſpects. (WHITE *on the regular Gradation in Man and Animals*, &c). In ſome other ſimiæ the leg and fore-arm exceed the thigh and arm. In other animals, although they are ſome varieties, the leg is generally longer than the thigh.

The femur of the mammalia is not arched as in the human ſubject: it poſſeſſes ſcarcely any neck; and the great trochanter aſcends beyond the head of the bone.

The fibula is behind the tibia in many animals, as the *dog* and the *rodentia*. It is conſolidated to that bone at its lower end in the *mole* and *rat*. It only exiſts as a ſmall ſtyloid bone in the *horſe*, and becomes anchyloſed to the tibia in an old animal.

The ſtructure of the metatarſus in the ruminating animals, and the horſe, is the ſame with that of the metacarpus.

The tarſus of the horſe is compoſed of ſix bones; and is the part known in common language by the name of the *hock*.

Animals of the genus *ſimia* and *lemur*, inſtead of having a great toe placed parallel with the others, are furniſhed with a real thumb: i. e. a part capable of being oppoſed to the other toes. Hence theſe animals can neither be called *biped*, nor *quadruped*, but are really *quadrumanous* or *fourhanded*. They are not deſtined to go either on two or four extremities, but to live in trees, ſince their four prehenſile members enable them to climb with the greateſt facility. So that CUVIER has denominated them "*les grimpeurs par excellence.*" (Leçons d' Anat. Comp. vol. 1. p. 493.) The prehenſile tail of ſeveral ſpecies is a further aſſiſtance in this way of life. The *opoſſum*, and others of the genus *didelphis*, have a ſimilar ſtructure with the *quadrumana*; and it anſwers the ſame purpoſe. Here however there is a ſeparate thumb on the poſterior extremity only, whence CUVIER calls them *pedimanes*.

Man is the only animal, in which the whole ſurface of the foot reſts on the ground: and this circumſtance ariſes from the erect ſtature, which belongs excluſively to him. In the *quadrumana*; in the *bear*, *hedgehog*, and *ſhrew*, (which are called by CUVIER *plantigrades*), the os calcis does not touch the ground.

The heel of a ſpecies of bear belonging to this country, viz. the *badger* (*urſus meles*), is covered with a long fur, which proves that this part cannot reſt on the ground; although the ſtructure both of the bones and muſcles of the lower extremity of this animal, approaches conſiderably to that of man. The ſame fact is ſtated of the bear itſelf, properly ſo called, by the Pariſian diſſectors, *Deſcription anatomique d'un cameleon, d'un caſtor, d'un ours*, &c. Paris, 1669, 4to. the plate is contained in BLASIUS's *Collection*, tab. 32.

In other animals the body is ſupported upon the phalanges of the toes, as in the *dog* and *cat;* in the horſe and ruminating animals no part touches the ground but the laſt phalanx. Here the elongation of the metatarſus removes the os calcis to ſuch a diſtance from the toe, that it is placed midway between the trunk and hoof.

CHAPTER III.

ON THE SKELETON OF BIRDS.

§ 46. THE ſkeleton of birds has conſiderable uniformity in the whole claſs; and it exhibits, when compared with the variouſly formed ſkeletons of mammalia, a very great and unexpected ſimilarity to that of the human ſubject [1].

§ 47. The ſkull of birds is diſtinguiſhed by this peculiarity, that the proper bones of the cranium [2], at leaſt in the adult animal, are not joined by ſutures, but are conſolidated as it were into a ſingle piece [3].

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[1] As that excellent naturaliſt BELON, has already ſhewn in his "*Hiſtoire de la Nature des Oiſeaux, avec leurs Naifs Portraits retirez du Naturel.*" Paris, 1555. fol. p. 40.

[2] Conſult on this ſubject VINC. MALACARNE "*of the Parts relating to the Brain of Birds*" in the *Memoirs of the Italian Society*, tom. 1 and 2.

[3] A peculiarity, which ſeems to be confined to the *cormorants*, muſt be here mentioned. There is a ſmall ſabre-ſhaped bone at the back of its vertex, which is ſuppoſed to ſerve as a lever in throwing back the head, when the animal toſſes the fiſhes, which it has taken, into the air, and catches them in

They have, without exception, only a ſingle condyle, placed at the anterior margin of the great occipital foramen. (See note (A) at the end of the chapter).

There is alſo, in the whole claſs, a bone of a ſomewhat ſquare figure, (called by the French *os carré*[4]), by which the lower jaw is articulated with the cranium on both ſides, in the neighbourhood of the ear. (See note (B) at the end of the chapter).

The oſſa unguis are common to birds with mammalia, but appear to be more general in the former than the latter: they are of conſiderable ſize, and muſt be diſtinguiſhed from the ſuperciliary[5] bones which probably belong to the *accipitres* (or predacious birds) only.

§ 48. The jaws are completely deſtitute of teeth. (See note (C) at the end of the chapter). The ſuperior maxilla, which is completely im-

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in its open mouth. But the ſame motion is performed by ſome other piſcivorous birds, who are unprovided with this particular bone. The whole ſkeleton of the *cormorant* is repreſented by COITER in the 4th of his excellent plates, which are attached to his edition of the "*Lectiones Fallopii de partibus Similaribus*," &c. Norib. 1575. folio.

[4] HERISSANT has given it this name in the *Mem. de l' Acad. des Sc.* 1748. But COITER has pointed it out in the work before quoted.

[5] See MERREM's *Obſervations relating to Zoology*, p. 120.

moveable

moveable in mammalia, has, with a few exceptions, more or leſs motion in birds[6]. It either conſtitutes a particular bone, diſtinct from the reſt of the cranium, to which it is articulated, as is the *Pſittaci*[7] (birds of the parrot kind); or it is connected into one piece with the cranium, by means of yielding and elaſtic bony plates; as is the caſe with birds in general. It is quite immoveable in a very few inſtances; as the tetrao urogallus (cock of the woods) and the rhinoceros bird[8].

§ 49. The proportionate magnitude of the bones of the cranium and jaws varies much in this claſs. The former are large in the owl; the latter are of vaſt magnitude in the rhinoceros bird[9].

§ 50.

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[6] Herissant *Sur les Mouvemens du Bec des Oiſeaux* in the *Mem. de l'Acad. des Sciences*, 1748. p. 345, with excellent plates.

[7] Labillardiere ſays alſo of the upper mandible of the *pelicanus varius*; "*cette Mandibule eſt mobile, comme celle des Perroquets.*" *Relation du Voyage*, &c. 1. p. 210.

[8] This at leaſt is the caſe, in a ſkull of this extraordinary animal in my collection.

[9] A moſt remarkable ſexual difference appears in the ſkull of the *creſted hens*: in theſe the frontal portion of the cranium is dilated into an immenſe cavity; on which the creſt of feathers is placed. This degeneracy of the formative impulſe, which is propagated to the offspring, is quite unparalleled in the whole animal kingdom. See Stobæus in

Act.

§ 50. One of the peculiar characteriſtic differences of the cranium of birds when compared to each other[10], conſiſts in the mode of ſeparation of the orbits, which are of great ſize in the whole claſs. In ſome they are ſeparated by a membranous partition only; in others by a more or leſs complete bony ſeptum. The relation, which the naſal and palatine openings bear to the upper jaw varies much, even in the different ſpecies of the ſame genus. They are ſmall in the *ſtork;* and on the contrary ſo large in the *crane* that the longeſt portion of the jaw appears to conſiſt merely of three thin portions of bone, placed far apart from each other, and converging towards the point of the bill.

§ 51. The want of motion in the back of birds, (their dorſal vertebræ have the ſpinous, and even the tranſverſe proceſſes, often anchyloſed) is compenſated by a larger number, and greater mobility of the cervical vertebræ; of which, to

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Act. Liter. Suec. v. 3. 1730. PALLAS *Spicileg. Zoolog.* fas. 4. SANDIFORT *Muſeum Lugd. Batav.* vol. 1. p. 306.

I have lately examined ſeveral heads of ſuch hens in a freſh ſtate, and have found that this peculiar dilatation of the cranium is filled by the hemiſpheres of the cerebrum; and it is ſeparated from the poſterior part, which holds the cerebellum, as in the common hen, by an intermediate contracted portion.

[10] See J. T. KLEIN, *Stemmata Avium.* Lipſ. 1759. 4to.

quote a few inſtances, the *raven* has 12, the *cock* 13, the *oſtrich* 18, the *ſtork* 19, and the *ſwan* 23.

§ 52. The trunk of birds has fewer cartilaginous parts than the correſponding diviſion of the ſkeleton in mammalia. That part of the ſpine, which belongs to the trunk is ſhort and rigid, and has no true lumbar vertebræ. Neither has any bird an os coccygis prolonged into a true jointed tail *.

§ 53. The pelvis of birds is chiefly formed by a broad and ſimple os innominatum; the lateral portions of which are of different figures in the ſeveral genera; but, inſtead of uniting below to conſtitute a ſymphyſis pubis, they are quite diſtant from each other. The *oſtrich* alone forms a remarkable exception to this rule; in as much as its pelvis, like that of moſt quadrupeds, is cloſed below by a complete junction of the oſſa pubis.

§ 54. Birds have fewer ribs than mammalia: the number, I believe, never exceeds ten pairs. The falſe ribs, i. e. thoſe, which do not reach to the ſternum, are directed forward; the true ones are joined to the margin of the ſternum by means of ſmall intermediate bones. The middle pairs are diſtinguiſhed by a peculiar flat proceſs, which is directed upwards and backwards.

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* See note (D), at the end of the chapter.

§ 55. The ſternum of theſe animals is prolonged below into a vertical proceſs, *(criſta)* for the attachment of the ſtrong pectoral muſcles. In the male wild ſwan *(anas cygnus)*, and in ſome ſpecies of the genus *ardea*, as the *crane*, this part forms a peculiar cavity for the reception of a conſiderable portion of the trachea. The criſta is entirely wanting in the *oſtrich* and *caſſowary*; where the ſternum preſents a plane and uniformly arched ſurface *.

§ 56. The wings are connected to the trunk by means of three remarkable bones [11]. The clavicles, which are always ſtrong, conſtitute ſtraight cylindrical bones. Their anterior extremities are connected to the ſternum, by means of a bone peculiar to birds; viz. the *forklike bone*, or, as it is more commonly termed, the *merry thought*. *(Furcula*, in

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* This peculiarity of ſtructure is accounted for by obſerving, that theſe birds have not the power of flying. The wings, which are very ſmall, aſſiſt in balancing the body, as they run.

[11] For an account of ſeveral differences in their ſtructure, See VICQ D'AZYR in his "*Memoires pour ſervir a l'Anatomie des Oiſeaux*," in the *Mem. de l'Acad. des Sc.* 1772. p. 626.

French *la lunette*, or *fourchette)* *. (See note (E) at the end of the chapter.)

§ 57. The bones of the wing may be compared on the whole to thoſe of the upper extremity in man, or the quadrumana; and conſiſt generally of an os humeri; two bones of the forearm; two of the carpus; two, which are generally conſolidated together, of the metacarpus; one bone of the thumb; and two fingers; of which that which lies towards the thumb conſiſts of two portions, the other only of one. The moſt remarkable deviation from this ſtructure, in reſpect to the number, as well as the formation and relative proportion of the bones, is found in the fin-like wings of the *penguins*. All the bones are here of a very remarkable flattened form, as if they had been preſſed; there are two ſupernumerary bones at the elbow; and the bone of the thumb is entirely wanting.

§ 58. The bony ſtructure of the lower extremities is more ſimple in birds, than in mammalia. In general it comprehends only the following bones, viz. the femur, the tibia, (to which, in ſome inſtances, is added a ſmall, thin, cloſely adhering pointed fibula) one metatarſal bone, and the toes. The place of the patella is ſupplied, in many caſes, by a proceſs of the tibia. As birds have neither a true fibula, nor tarſus, their tibia is immediately articulated with the metatarſus. There is, in moſt of this claſs, a peculiar progreſſive increaſe in the number of phalanges of the toes: the great toe has two; the next three; the middle one, four; and the outer one, five[12]. The *pſittaci* have, however, a a peculiar croſs-bone, belonging to the great toe*.

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* The *oſtrich* and *caſſowary* have indeed no ſeparate *furcula*; but on either ſide of the front of the cheſt, an elongated flat bone, conſiſting of a rudiment of the furcula, with the clavicle and ſcapula conſolidated into one piece.

Additional Notes to the Third Chapter.

(A) This ſtructure gives the head a great freedom of motion, particularly in the horizontal direction. It enables the bird to place its bill between the wings, when aſleep; a ſituation, in which none of the mammalia can bring the ſnout.

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[12] Several excellent remarks on this, as well as other parts of the oſteology of this claſs, may be found in Profeſſor SCHNEIDER's inſtructive work, "*Commentar. ad reliqua Librorum Frederici 2ndi Imperatoris*, p. 30.

* See note (F), at the end of the chapter.

(B) The *os quadratum* has a true articulation, both with the lower mandible and with the cranium. Another ſmall bone is connected to it, and reſts by its oppoſite end againſt the palate. Hence, when the ſquare bone is brought forwards, which it is by the depreſſion of the lower mandible, and in a greater degree by ſome particular muſcles, the ſecond bone preſſes againſt the palate, ſo as to elevate the upper jaw.

(C) The bill of birds may be conſidered, in ſome degree, as ſupplying the place of teeth; yet, as none of theſe animals maſticate their food, but ſwallow it whole, the bill can only be compared to the inciſors of ſuch animals, as uſe them for ſeizing and procuring their food.

It conſiſts of a horny fibrous matter, ſimilar to that of the nail, or of proper horns; and is moulded to the ſhape of the bones, which conſtitute the two mandibles, being formed by a ſoft vaſcular ſubſtance, covering theſe bones. Its form and ſtructure are as intimately connected with the habits and general character of the animal, as thoſe of the teeth are in the mammalia. Hence an enumeration of its different figures and conſiſtence, belongs properly to the department of natural hiſtory, where it forms the foundation of claſſific diſtinctions.

The accipitres, or rapacious birds, have it very hard, hooked at the end, and furniſhed with a proceſs on either ſide; calculated, therefore, in all reſpects,

ſpects, for ſeizing and lacerating their prey. Thoſe of the *parrot* kind have it alſo hard, for bruiſing the firmer vegetable fruits; and the *wood-pecker*, *nuthatch*, &c. for penetrating the bark of trees.

Thoſe birds, which take a ſofter kind of food, and which require a ſenſe of feeling in the part, for diſtinguiſhing their food in mud, water, &c. have it approaching to the ſoftneſs of ſkin. Such are the *duck*, *ſnipe*, *woodcock*, &c.

In ſeveral claſſes, particularly the *accipitres* and *gallinæ*, the baſe of the bill is covered with a ſoft ſkin, called the *cire*, of unknown uſe.

(D) The number of cervical vertebræ in birds, varies from ten to twenty-three; thoſe of the back from ſeven to eleven. From hence to the tail, they are conſolidated into one piece with the os innominatum. The tail has from ſeven to nine pieces.

The length of the neck increaſes in general, in proportion to that of the legs.

The cervical vertebræ are not articulated by plane ſurfaces, but by cylindrical eminences, which admit a more extenſive motion, as they conſtitute real joints, inſtead of ſynchondroſes. Four or five of the upper pieces only bend forwards; while the lower ones are confined to flexion backwards. Hence the neck of a bird acquires that double bend, which makes it reſemble the letter S. It is by rendering the two curvatures more convex, or more ſtraight, that the neck is ſhortened or elongated. The great mobility of the neck, enables birds to touch every point of their own body with the bill, and thus to ſupply the want of the prehenſile faculty of the ſuperior extremity.

(E) The point of the fork-like bone is joined to the moſt prominent part of the keel of the ſternum; and the extremities of its two branches are tied to the humeral end of the clavicles, and the front of the ſcapulæ, juſt where theſe bones join each other, and are articulated with the humerus. Hence it ſerves to keep the wings apart in the rapid motions of flying. "As a general obſervation, it may be ſtated, that the *fork* is ſtrong and elaſtic; and its branches wide, arched, and carried forwards upon the body, in proportion as the bird poſſeſſes ſtrength and rapidity of flight; and accordingly the *ſtruthious birds* (*oſtrich* and *caſſowary*), which are incapable of this mode of progreſſion, have the fork very imperfectly formed. The two branches are very ſhort, and never united in the *African oſtrich*, but are anchyloſed with the ſcapula and clavicle. The *caſſowary* has merely two little proceſſes from the ſide of the clavicle, which are the rudiments of the branches of the fork. In the *New Holland oſtrich* there are two very ſmall thin bones, which are attached to the anterior edge of the dorſal end of the clavicles by ligament; they are directed upwards towards the neck, where they are faſtened to each other by means of a ligament, and have no connection whatever with the ſternum."

MACARTNEY, in REES's *Cyclopædia*. Article BIRDS, *Anatomy of*.

(F) Birds certainly have a fibula, contrary to the aſſertion of the author; but it is ſmall, and ſoon anchyloſed to the tibia.

The lower end of the bone, which anſwers to the tarſus and metatarſus, forms as many proceſſes as there are toes; and each of theſe has a pulley, for articulation, with its correſponding toe.

The vaſt length of the leg in the wading birds *(grallæ)*, the *oſtrich*, and *caſſowary*, is produced by the tibia, and common bone of the tarſus and metatarſus; for the femur is comparatively ſhort.

" The *ſtork*, and ſome others of the *grallæ*, which ſleep ſtanding on one foot, poſſeſs a curious mechaniſm, for preſerving the leg in a ſtate of extenſion, without any, or at leaſt with little muſcular effort. There ariſes from the fore-part of the head of the metatarſal bone, a round eminence, which paſſes up between the projections of the pulley, on the anterior part of the end of the tibia. This eminence affords a ſufficient degree of reſiſtance to the flexion of the leg, to counteract the effect of the oſcillations of the body, and would prove an inſurmountable obſtruction to the motion of the joint, if there were not a ſocket within the upper part of the pulley of the tibia, to receive it when the leg is in the bent poſition. The lower edge of the ſocket is prominent and ſharp, and preſents a ſort of barrier to the admiſſion of the eminence, that requires a voluntary muſcular exertion of the bird to overcome, which being accompliſhed, it ſlips in with ſome force, like the end of a diſlocated bone."

MACARTNEY, loco citato.

CHAPTER IV.

ON THE SKELETON OF AMPHIBIA.

§ 59. THE general form of the body, and conſequently the ſtructure of the ſkeleton varies ſo much, in the firſt place, in the two orders of this claſs, viz. the *four-footed amphibia*, and the *ſerpents*; and ſecondly, in the three leading claſſes of the firſt order, namely, the *teſtudines*, the *frogs*, and the *lizards*; that it will be beſt to arrange our obſervations on this ſubject, according to the natural diviſions of the orders and claſſes.

§ 60. The *teſtudines* (turtles and tortoiſes), whoſe whole ſkeleton [1], and indeed whoſe whole body has a very peculiar ſtructure, are entirely toothleſs; they have, however, a kind of os intermaxillare in the upper jaw. The horny covering of the jaws, particularly the upper one, has ſome reſemblance to the horſe's hoof, in the mode of its connection with the jaw. The cavity, containing the brain, is extremely ſmall, in compariſon with the ſize of the ſkull; the greateſt part of which, in the turtle, is occupied by the large lateral hollows, holding the eye, and the powerful muſcles that move the lower jaw. (See note (A) at the end of the chapter.)

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[1] Good repreſentations of the whole ſkeleton may be found in COITER, CHESELDEN, and particularly in J. D. MEYER's "*Paſtime, with Conſiderations of curious Repreſentations of all Kinds of Animals,*" &c. v. 1. p. 29. v. 2. p. 62. The individual parts are repreſented in GIOV. CALDESI's *Anatomical Obſervations relating to Turtles.* Florence, 1687. 4to.

§ 61. The trunk is conſolidated with the two great ſhells of the animal; the dorſal vertebræ and ribs being attached to the upper, the ſternum being fixed in the lower or abdominal ſhell. The upper bony covering, or that of the back, conſiſts of about fifty pieces; which are partly connected together by real ſutures.

§ 62. The ſame bones are found in the pelvis of theſe animals, as in the mammalia; but the proportion of their relative ſize is inverted. For inſtance, the oſſa pubis are ſo deep and broad, that they form the largeſt flat bones in the whole ſkeleton, while the ilia are the ſmalleſt.

§ 63. The form and poſition of the ſcapula and clavicle are the moſt extraordinary. The former has a moſt anomalous ſituation towards the under part of the animal, juſt behind the abdominal ſhell; the latter conſiſts of two pieces, joined at an acute angle, to which the humerus is articulated.

§ 64. *Frogs* and *toads*[2] have no teeth[3]. Their ſpine is ſhort, terminates behind in a ſtraight and ſingle bone, which is received into the middle of the ſomewhat fork-like os innominatum.

§ 65. They have no ribs; but the dorſal vertebræ are furniſhed with broad tranverſe proceſſes. The ſcapula, which is thin and flat, and a pair of bones, correſponding to the clavicle, are joined to the ſternum.

§ 66. The bone of the fore-arm and of the leg have a peculiarity of ſtructure, in theſe animals, which deſerves obſervation. Theſe bones conſiſt of a ſingle piece, which is ſolid in the middle, but divided at either extremity, into two conical portions, having manifeſt medullary cavities[4].

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[2] Skeletons of the frogs and toads of this country (Germany), may be ſeen in the well-known chef d'œuvre of Roesel, "*De Ranis Noſtratibus.*" The ſingular ſkeleton of the *rana pipa* (Surinam toad), is accurately deſcribed and delineated in the firſt faſcic. of Profeſſor Schneider's *Hiſtor. Amphibior.* It is particularly diſtinguiſhed by the large lateral proceſſes of the ſacrum, and by a bony cavity *(ciſta Schneid.)* of unknown uſe, placed behind the ſternum, and belonging excluſively, as it ſhould ſeem, to this animal.

[3] It muſt be underſtood, that we ſpeak here of real teeth; and not of what are called the denticulated margin of the jaws.

[4] See Troja's "*Memoir, concerning the ſingular Structure of the Tibia and Ulna in Frogs and Toads;*" in his "*Experiments on the Regeneration of Bones,*" in Italian. Naples, 1779. p. 250.

§ 67. The *crocodile*[5] may be taken as an example of the claſs of *lizards*[6], on account of ſome remarkable peculiarities of ſtructure. In no other animal are the jaws of ſuch immenſe ſize, in compariſon with the extremely ſmall cavity of the cranium. The anterior part of the upper jaw, conſiſts of a large intermaxillary bone; and the lateral portions of the lower maxilla, are formed of ſeveral pieces joined together. The lower jaw[7] is articulated, in a peculiar manner, in theſe animals: it has an articular cavity, in which a condyle[8] of the upper jaw is received.

§ 68. Their numerous teeth have this peculiarity of ſtructure; that, in order to facilitate their change,

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[5] The ſkeleton of the *crocodile*, is repreſented in N. GREW's "*Muſeum Regalis Societatis.*" Lond. 1681. Alſo in FAUJAS ST. FOND, *Hiſtoire Naturelle de la Montagne de St. Pierre de Maeſtricht.*

[6] The ſkeleton of the common *green lizard*, may be ſeen in COITER, pl. 4; MEYER, tome 1. pl. 56; that of the *ſalamander* and *waternewt* are alſo given in MEYER; that of the *chamæleon* is prefixed to CHESELDEN's 6th ch.

[7] The commencement of this kind of articulation, is ſeen in the jaw of the teſtudines.

[8] The condyle reſembles, in ſome meaſure, the pulley at the inferior extremity of the humerus (the *trochlea*, or *rotula* of ALBINUS); this, at leaſt, is the caſe in the ſkull of an *alligator*, which I have before me.

The old error, of ſuppoſing that the upper jaw of the crocodile is moveable, and the lower, on the contrary, incapable change, there are always two, of which one is contained within the other [9].

§ 69. But the moſt ſurpriſing ſingularity in the ſkeleton of the crocodile, conſiſts in an abdominal ſternum, which is quite different from the thoracic ſternum, and extends from the enſiform cartilage to the pubis, apparently for the purpoſe of ſupporting the abdominal viſcera [10].

§ 70.

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ble of motion, which has been adopted even by ſuch anatomiſts as Vesalius and Columbus, has perhaps ariſen from this peculiar mode of articulation. An examination of the cranium ſhews, that if the lower jaw remains unmoved, the whole remainder of the ſkull may be carried backwards and forwards by means of this joint. And ſuch a motion is proportionally eaſier in the preſent inſtance, than in any other animal, both on account of the very great relative ſize of the lower jaw, as well as from its anomalous mode of articulation. There is, however, no motion of the upper jaw-bone only, ſimilar to that which occurs in moſt birds, ſerpents, and fiſhes.

[9] Sometimes three, according to Retzius, *Animadverſ. circa Crocod.* 1797. 4to.

[10] In the ſkeletons of three *Eaſt Indian crocodiles*, which I have examined, there were ten pairs of true, and two of falſe ribs. The former had bony appendages; and a third, intermediate portion between the chief piece of the rib and the appendix. The abdominal ſternum conſiſted of ſeven pairs of a cartilaginous arches connected together. The ſix front pairs were interrupted by open intervals; and the ſpace between the laſt pair and the pubis, was filled by a broad piece of cartilage. A ſomewhat ſimilar ſtructure in the *crocodile*

§ 70. The ſerpents[11] have an upper jaw, unconnected with the reſt of the ſkull, and more or leſs moveable of itſelf.

§ 71. We find in their teeth, the important and clearly defined difference, which diſtinguiſhes the poiſonous ſpecies of ſerpents, from the much more numerous innoxious tribes.

The latter have, in the upper jaw, four maxillary bones, beſet with ſmall teeth, which form two rows, ſeparated by a conſiderable interval from each other. One of theſe is placed along the front edge of the jaw; the other is found more internally, and is ſituated longitudinally on either ſide of the palate.

The external row is wanting in the poiſonous ſpecies; which have, in their ſtead, much larger tubular fangs, connected with the poiſon bladder, and conſtituting, in reality, bony excretory ducts, which convey the venom into the wound, inflicted by the bite of the animal[12].

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of the Nile, is deſcribed by S. VESLINGIUS, in his *Obſerv. Anat.* p. 43; and in the *alligator*, by PLUMIER, in the *Memoires de Trevoux*, of January 1704.

[11] Skeletons of ſeveral ſnakes are contained in the work of MEYER, above quoted.

[12] Specimens are delineated, for the ſake of compariſon, in the 4th part of my "*Delineations*," &c. tab. 37, where the heads of a rattleſnake *(crotalus)* and a *boa*, are repreſented with their mouths open.

§ 72. It appears, in general, that the number of vertebræ in red-blooded animals, is in an inverſe proportion with the ſize and ſtrength of their external organs of motion. Serpents, therefore, which entirely want theſe organs, have the moſt numerous vertebræ; ſometimes more than 300. (See note (B) at the end of the chapter).

The laſt vertebræ of the tail, in the *rattleſnake*, are broad, and covered by the firſt hollow pieces of the *horny rattle:* the ſucceeding portions of this ſingular and myſterious organ[13], are connected to each other in a moſt curious way.

§ 73. Serpents poſſeſs by far the greateſt number of ribs; which amount, in ſome, to 250 pairs. It is neceſſary to mention here the *coſtæ ſcapulares* of the *cobra di cabelo (coluber naiæ)*, which enable the animal to inflate its neck[14].

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[13] For the probable uſe of this organ, which belongs ſo excluſively to the *rattleſnake;* and for the aſſiſtance, which it may afford to this inactive animal, by drawing towards it the frightened birds (which, indeed, may have given riſe to the ſtories concerning its ſuppoſed power of faſcination). See VOIGT's *Magazine, for the neweſt Occurrences in Natural Hiſtory*, vol. I. p. 37. "On the faſcinating power of the rattleſnake, particularly with reſpect to a work of Dr. Barton's," in German.

[14] This is alſo the caſe with other ſpecies of the *coluber;* namely, the Egyptian *coluber haje,* which can dilate its neck very conſiderably, when enraged.

Serpents are the only red-blooded animals, which have no ſternum *.

Additional Notes to the Fourth Chapter.

(A) This circumſtance is ſtill more remarkable in the *crocodile.* The cranium of an individual, meaſuring thirteen or fourteen feet, will hardly admit the thumb: and the area of its ſection does not conſtitute the twentieth part of that of the whole head.

The *chameleon* affords another inſtance of the ſame ſtructure: its brain, according to the deſcription of the Pariſian diſſectors, does not ſeem larger than a pea; and the whole of the head, which is of conſiderable ſize, conſiſts of the large maxillary bones, the orbits, and immenſe temporal foſſæ, which, not being ſeparated by any partition, give the cranium a very ſingular appearance.

See the *Deſcription anatomique d'un Cameleon,* &c. or Blasius's *Collection,* tab. 14.

(B) In may be obſerved in confirmation of this remark, that the number of vertebræ is very great in fiſhes of an elongated form; viz. in the *eel*, which has above one hundred. The *porpoiſe*, which has no organs of motion, which deſerve mentioning, has between ſixty and ſeventy.

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* For ſome others remarks, concerning the head of the amphibia, ſee note (C) at the end of the chapter.

Birds, which have ſuch vaſt power of locomotion by means of their wings, have very few vertebræ, if we conſider the anchyloſed ones as forming a ſingle piece. And the *frog*, with its immenſe hind extremities, has a very ſhort ſpine, conſiſting of ſtill fewer pieces.

(C) The occiput is connected to the atlas by a ſingle condyle in the *crocodile* and *turtle:* in the *lizard* and *tortoiſe* there is a ſlight appearance of diviſion into two ſurfaces: in the *frog* and *toad* there are two condyles; and in the *ſerpents* there are three articular ſurfaces on a ſingle tubercle.

The condyle of the turtle being deeply imbedded in the atlas, the motions of the articulation muſt be limited: the protraction and retraction of the head in this animal is effected by the flexion and extenſion of the vertebræ of the neck.

The lower jaw is articulated with an eminence of the cranium in the *lizards*, *turtles*, *frogs*, *ſalamanders*, *blindworms*, *(anguis fragilis)* and *amphisbæna;* beſides the crocodile in which the author mentions it. This bony eminence, is compared by CUVIER to the *os quadratum* of birds. The lower jaw only is moveable in theſe animals. Its articulation in the turtle is by means of a ginglymus. In all the venomous ſerpents the upper jaw is moveable on the head, as in birds: theſe animals require as extenſive an opening of the mouth as poſſible, ſince they ſwallow others whole, actually larger than their own body.

CHAPTER V.

ON THE SKELETON OF FISHES.

§ 74. We ſhould naturally conclude, from obſerving the great diverſity in the general form of fiſhes, that the ſtructure of their ſkeleton muſt be equally various[1]. They agree together, however, on the whole, in having a ſpine, which extends from the cranium to the tail-fin; and in having the other fins, particularly thoſe of the thorax and abdomen, articulated with peculiar bones, deſtined to that purpoſe. They have in general many more bones unconnected with the reſt of the ſkeleton, than the animals of the preceding claſſes[2].

§ 75.

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[1] Delineations of the ſkeleton of moſt marine fiſhes are ſtill wanting. A beautiful view of the *ſkate* is given by Cheselden in the beginning of his work. Meyer has repreſented the ſkeletons of twenty-five freſh-water fiſhes in the two firſt volumes of his book, which has been frequently quoted. That of the *carp* may be ſeen in Duhamel *Traité des Pêches*, (a part of the great work entitled, *Deſcription des Arts and Metiers,*) pl. 2. ſect. 1. tab. 3.

[2] There are ſome excellent remarks on the ſkeleton of fiſhes

§ 75. The cranium in ſeveral cartilaginous fiſhes, (in the *ſkate* for inſtance) has a very ſimple ſtructure, conſiſting chiefly of one large piece. In the bony fiſhes, on the contrary, its component parts are very numerous; amounting to 80 in the head of the *perch*. Moſt of the latter have a more or leſs moveable under-jaw.

§ 76. Great variety in the ſtructure of the teeth is obſerved in this claſs. Some genera, as the ſturgeon, are toothleſs. Their jaws, which are diſtinct from the cranium, form a moveable part, capable of being thruſt forwards from the mouth, and again retracted.

§ 77. Thoſe fiſhes, which poſſeſs teeth, differ very much in the form, number, and poſition of theſe organs. Some ſpecies of *ſparus*, (as the *S. probato-cephalus)* have front-teeth almoſt like thoſe of man[3]; they are provided with fangs, which are

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fiſhes in general, by Profr. AUTENRIETH in WIEDEMANN'S *Archives*, vol. 1. p. 2.

On the ſkeletons of particular orders of fiſhes, ſee VICQ D'AZYR, in the 7th vol of the "*Memoires preſentés a l' Acad. des Sciences.*" It is tranſlated into German, with remarks and additions by Profeſſor SCHNEIDER, in his "*Collection of Anatomical Obſervations and Remarks towards elucidating the Hiſtory of Fiſhes.*" Leipzig, 1795. 8vo.

[3] AUGUSTIN SCILLA *de Corporibus Marinis lapideſcentibus*. Rome, 1759. 4to. tab. 2.

are contained in alveoli. In many genera of fiſhes, the teeth are formed by proceſſes of the jaw-bones covered with a cruſt of enamel. In moſt of the ſharks, the mouth is furniſhed with very numerous teeth for the ſupply of ſuch as may be loſt. The *white ſhark* has more than two hundred, lying on each other in rows, almoſt like the leaves of an artichoke. Thoſe only, which form the front row, have a perpendicular direction, and are completely uncovered. Thoſe of the ſubſequent rows are, on the contrary, ſmaller; have their points turned backwards, and are covered with a kind of gum. Theſe come through the covering ſubſtance, and paſs forward when any teeth of the front row are loſt[4]. It will be underſtood from this deſcription, that the teeth in queſtion cannot have any fangs.

The ſaw-fiſh only *(ſqualus priſtis)* has teeth implanted in the bone on both ſides of the ſword-ſhaped organ, with which its head is armed.

In ſome fiſhes the palate, in others the bone of the tongue (as in the *frog-fiſh)*, in others (as in ſeveral of the ray-kind) the aperture of the mouth forms a continuous ſurface of tooth[5]. (See note (A) at the end of the chapter.)

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[4] See HERISSANT in the *Mem. de l'Acad. des Sc. de Paris*, 1749, p. 155. And W. ANDRE in the *Philoſ. Tranſ.* vol. 74. p. 274.

[5] One of the moſt ſurpriſing formations about the mouth

§ 78. In the long ſhaped fiſhes with ſhort fins, the ſpine conſiſts of a proportionally greater number of vertebræ; of which the eel, for inſtance, has more than 100, and ſome ſharks even more than 200. The main-piece, or body, as it is called of theſe vertebræ, is of a cylindrical figure, with a funnel ſhaped depreſſion on both ſurfaces, and concentric rings, which are ſaid to vary in number, according to the age of the animal. The ſpinal marrow paſſes above theſe, in a canal formed at the roots of the ſpinous proceſſes.

The ribs are articulated with what are called the dorſal vertebræ in moſt of the ſpinous fiſhes; but in ſome they are without this connection; and in the cartilaginous fiſhes proper ribs cannot be ſaid to exiſt.

§ 79. Of the peculiar bones, which ſerve as a baſis for the fins, that of the pectoral fin may be compared to the ſcapula, and that of the abdominal in ſome meaſure with the os innominatum[6].

§ 80.

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occurs in a Weſt Indian ſpecies of *ſkate (raia flagellum)*: it is deſcribed and delineated in the *Philoſ. Tranſ.* vol. 19. p. 674. by SLOANE, as the tongue of the animal. The ſpecimen, which I poſſeſs, conſiſts of a flat bone, about five inches long, two broad, and of the thickneſs of the thumb. It is compoſed of 15 curved portions, connected together lengthwiſe; and each of theſe arches is covered above with 60 ſmall teeth, which lie cloſe together.

[6] I poſſeſs a ſpecimen of the ſingular bone, relating to this ſubject,

§ 80. Laſtly, many fiſhes are furniſhed with merely muſcular bones (*oſicula muſcullorum* of Artedi) which are ſometimes bifurcated, are always ſituated among the muſcles, and facilitate their motion.

Additional Note to the Fifth Chapter.

(A) Great variety exiſts in the teeth of fiſhes; and their ſtructure, formation, and mode of growth have been but imperfectly explained hitherto.

Many fiſhes have ſimple teeth, formed of a *bony ſubſtance*, covered by *enamel*, and probably formed

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ſubject, which has been repreſented in the *Muſeum Wormianum*, p. 270, in the *Muſeum Regium* of *Jacobæus*, and in Olearius, *Gottorf. Kunſtkammer*; and which, for a long time has been conſidered as a very obſcure ſubject. It is thick, of a roundiſh flat form, and nearly reſembling a ſmooth cheſnut in form and ſize. It forms on one ſide a bony point; and on the other is articulated, by means of a very remarkable ginglymus, with two ſmall bones of different magnitude, and reſembling the point of an arrow. It belongs moſt probably to an Eaſt Indian *chætodon*, (probably to the *Ch. arthriticus* Schneid); the larger piece being the baſis of the back-fin, and the ſmaller conſtituting the firſt radii of that fin. See W. Bell's *Deſcription of a Chætodon, called by the Malays, Ecan Bonna,* in the Philoſ. Tranſ. 1793.

as in the mammalia. Theſe are the moſt common, and may be ſeen in the *pike*. When the crown has completely appeared, the root becomes anchyloſed to the jaw.

In other caſes they adhere to the gum only, or at leaſt to a firm cartilaginous ſubſtance, which covers the jaw. This is exemplified in the *ſhark*. Theſe teeth ſeem not to be formed, as thoſe of the mammalia are, by the depoſition of ſucceſſive layers one within the other; but in a manner more nearly reſembling the formation of bone. They are at firſt ſoft and cartilaginous, and paſs by ſucceſſive gradations, into a ſtate of hardneſs and denſity, not inferior to that of ivory.

A third kind of teeth conſiſts of an aſſemblage of tubes, covered externally by enamel, and connected to the jaw by a ſofter ſubſtance, which probably ſends proceſſes or veſſels into thoſe bony tubes. This is the caſe with the pavement, as we may call it, of teeth, that covers the jaws of the *ſkate*.

A ſimilar ſtructure is obſerved in the *anarrhichas lupus*; where the teeth, compoſed of bony tubes, are connected to ſpongy eminences of the jaws, which may be compared to epiphyſes; and on their ſeparation leave a ſurface like that from which the antler of the deer falls off.

Beſides the two jaws, fiſhes have teeth implanted in the bones of the palate; in that which correſponds to the vomer; in the os hyoides; in the bones which ſupport the franchiæ; and in thoſe which are placed at the top of the pharynx. The *ſalmon* and *pike* have them in all theſe ſituations.

CHAPTER VI.

ON THE ŒSOPHAGUS AND STOMACH.

§ 81. AFTER the comparative view, which we have now taken, of the ſkeleton, as influencing the general form of the red-blooded animals, we proceed to conſider the other parts of the animal ſtructure, and their functions. The ordinary diviſion into four claſſes of functions may be here retained, as ſufficiently applicable on the whole, although it is in ſtrictneſs ſubject to much limitation. The particular claſſes of animals will be conſidered in the ſubdiviſion of each chapter, according to the arrangement moſt uſually followed in teaching zoology.

§ 82. The *natural functions*, as they are called, which include, in their moſt extenſive ſenſe, the whole proceſs of nutrition, very properly take the lead on this occaſion. In the firſt place, they exiſt in all claſſes of animals without exception; they are indeed common to plants and animals: ſecondly, the peculiar mode of their performance in animals, conſtitutes the moſt diſtinguiſhing character of an animal. For they ſeek their food by voluntary motion, and convey it into the ſtomach through a mouth [1].

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[1] Partial exceptions to this general rule may be drawn; 1ſt, From thoſe animals in which no mouth has been hitherto diſcovered; for inſtance, as ſome *animalcula infuſoria*, and in a certain ſenſe ſome *meduſæ*, which, inſtead of poſſeſſing a ſimple opening, take in their nouriſhment through many apertures. 2dly, From thoſe, in which no manifeſt voluntary motion has been hitherto obſerved, as in ſeveral real *hydatids*. Phyſiologiſts have lately gone further, and have declared certain organized bodies, in which neither of the above-mentioned characters, neither a mouth nor voluntary motion could be diſcovered, to be animals. Such, for example, are the dropſical bladders, occaſionally found in the abdomen of perſons, who have laboured under aſcites, (rarely in any animal except man,) in vaſt numbers, and of various ſizes from that of a gooſe's egg, to the head of the ſmalleſt needle. I have examined a great number of theſe, which were found in a dropſical old man, whoſe diſeaſe and diſſolution are related by Richter, in Loder's *Surgical Journal*, vol. 3. p. 415. Theſe differ in their whole ſtructure, and particularly in the formation of their membranes, much more from the true *hydatids*, than from ſome ſimple morbid watery cyſts, which are met with not unfrequently in warm-blooded animals, and conſiſt ſo indiſputably of a mere unnatural formation of veſſels and membranes, that no perſon could think of aſcribing to them an independent animal exiſtence. I have now before me ſimilar cyſts from a hen, the largeſt of which, (about the ſize of a ſmall hen's egg), like thoſe of the above-mentioned patient, were quite unattached; the reſt appeared, on the firſt examination, from their connection with the ovarium, to be nothing elſe but *calyces*, containing from a morbid cauſe, lymph inſtead of yolk.

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(A) MAMMALIA.

§ 83. We have already ſhewn, in the ſecond chapter, the moſt important circumſtances relating to the mouth. Many ſpecies of the genus *ſimia*, as well as the *hamſter*, *(marmota cricetus)* and ſome ſimilar ſpecies of the *marmot*, are provided with *cheek pouches*, in which the former, who live on trees, place ſmall quantities of food as a reſerve: the latter employ theſe bags to convey their winter proviſion to their burrows [2]. (See note (A) at the end of the chapter).

§ 84. The peculiar glandular and moveable bag, *(burſa faucium)*, which is placed behind the palate, has hitherto been only obſerved in the camels of the old world: and it probably ſerves

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I have however lately diſſected a *ſimia cynomolgus*, whoſe lungs, liver, and omentum were beſet with an abundance of watery cyſts of various ſizes. The fluid of theſe cyſts contained an innumerable quantity of microſcopical bodies, which were found, by the employment of ſtrong magnifying powers, to be *hydatids*, with a well-formed circle of hooks, and mouth, and conſequently muſt be conſidered as true independent animals.

[2] An accurate deſcription and delineation of theſe bags may be found in SULZER's "*Eſſay towards the Natural Hiſtory of the Hamſter,*" in German, p. 41. 58. tab. 3. One of the moſt maſterly zoological and zootomical monographs that has ever been publiſhed.

to lubricate the throat of theſe animals in their abode in the dry ſandy deſarts which they inhabit [3]. (See note (B) at the end of the chapter.)

§ 85. The œſophagus of quadrupeds is diſtinguiſhed from that of the human ſubject by poſſeſſing two rows of muſcular fibres, which purſue a ſpiral courſe, and decuſſate each other. In thoſe carnivorous animals, which ſwallow voraciouſly, as the *wolf*, it is very large; on the contrary, in many of the larger *herbivora*, and particularly in ſuch as ruminate, its coats are proportionally ſtronger [4].

The opening of the œſophagus into the ſtomach is marked by ſome differences, both with regard to its ſize, and to the mode of termination. We underſtand, from obſerving theſe points, why ſome animals, as the *dog*, vomit very eaſily, while others, as the *horſe*, are ſcarcely ſuſceptible of this proceſs[5], except in extremely rare inſtances[6].

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[3] See HOME's *Life of* J. HUNTER, prefixed to the poſthuous works of the latter, on "*the blood, inflammation,*" &c. p. 41. According to CUVIER, the common camel only, with one protuberance *(the dromedary)*, poſſeſſes this œſophageal pouch, and thruſts it forwards only at the rutting ſeaſon. *Ménagerie du Muſeum National*, pl. 1.

[4] GREW may be conſulted reſpecting the œſophagus, as well as the whole alimentary canal of ſeveral animals of the different claſſes. See his *Muſeum Regalis Societatis.*

§ 86. The form, ſtructure, and functions of the ſtomach, are ſubject to great variety in this claſs of animals. In moſt carnivorous quadrupeds[7], particularly thoſe of a rapacious nature, it bears a conſiderable reſemblance, on the whole, to that of the human ſubject: its form, however, differs in ſome caſes, as in the ſeal *(phoca vitulina)*, where the œſophagus enters directly at the left extremity, ſo that there is no blind ſac formed in the ſtomach. In ſome animals, as in the *lion*, *bear*, &c. it is divided by a ſlight contraction in its middle, into two portions. Its coats, particularly the muſcular one, are very ſtrong in the carnivora[8].

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[5] See Profeſſor NEBEL, *De Noſologiâ Brutorum cum Hominum Morbis comparatâ*. Gieſs. 1798.

[6] It ſeems extraordinary on the firſt conſideration, that the ruminating animals, in whom the paſſage of the food form the firſt ſtomach into the œſophagus is very eaſy, ſhould not be excited to vomit without ſuch difficulty.

I poſſeſs, through the kindneſs of Mr. HANEMANN, director of the veterinary ſchool at Hanover, an hair-ball which was diſcharged by vomiting from the ſtomach of a cow, which laboured under an affection of the digeſtive powers. The ſubſtance in queſtion was diſcharged with violence, after the employment of ſome white hellebore placed under the integuments of the breaſt. A more detailed account will be found in VOIGT's "*Magazine for the neweſt Occurrences in Natural Hiſtory.*" vol. 2. p. 637.

[7] H. C. SCHROEDER, *De Digeſtione Animalium Carnivororum*, Goett. 1755, 4to.

§ 87. In ſome *herbivora* the ſtomach has an uniform appearance externally; but it is divided into two portions internally, either by a remarkable difference in the two halves of its internal coat[9], as in the *horſe*[10], or by a valvular elongation of this membrane, as in ſeveral animals of the mouſe-kind. This is alſo the caſe in the *hare* and *rabbit*, where alſo the food in the two halves of the ſtomach, differs very much in appearance, particularly if the animal has been fed about two hours before death. (See note (C) at the end of the chapter).

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[8] We muſt not however truſt implicitly to Roederer, when he ſays that "the bear has two ſtomachs, the firſt and largeſt of which is formed like that of a carnivorous animal, the ſecond and ſmaller like that of birds, which feed on hard ſeeds."

[9] On the whole internal ſurface of the horſe's ſtomach, there are found, in vaſt abundance, particularly in ſpring, the larvæ of two ſpecies of æſtrus; viz. the *æſtrus equi* (which Linnæus called *æſtrus bovis)*, and the *æ. hæmorrhoidalis*, the true hiſtory of which has been elucidated for the firſt time in modern days, by that excellent veterinary ſurgeon, Mr. Bracy Clark, in the *Tranſactions of the Linnæan Society*, vol. 3. Figures of the *æs. equi* and its larvæ are given in my "*Delineations*, &c." pl. 5.

[10] Bertin in the *Mem. de l' Acad. des Sc. de Paris*, 1746.

§ 88. In ſome other mammalia, particularly the herbivorous ones, this organ conſiſts of two or more portions manifeſtly diſtinct externally, and forming as many ſtomachs. There are two of theſe in the *hamſter*[11]; three in the *kanguroo*[12] and *tajaçu*[13]; four in the *ſloths*[14].

The carnivorous cetacea have alſo a complicated ſtomach, conſiſting in ſome ſpecies of three, in others of four, and even of five ſubdiviſions[15].

§ 89. The moſt complicated and artificial arrangement, both with reſpect to ſtructure and mechaniſm, is found in the well known four ſtomachs of the ruminating animals with divided hoofs; of this, we ſhall take as examples, the *cow* and *ſheep*[16].

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[11] This is excellently deſcribed by SULZER, in his work above quoted.

[12] *Voyage a la Recherche de la Perouſe.* T. I. p. 134.

[13] TYSON in the *Philoſ. Tranſ.* vol. 13.

[14] DAUBENTON, vol. 13. p. 54. and 63. and WIEDEMANN'S *Archives*, vol. I.

[15] TYSON'S *Anatomy of a Porpoiſe*, London, 1680. 4to. HUNTER in SCHNEIDER'S "*Contributions towards the Natural Hiſtory of Whales.*" in German, pt. I.

[16] From the multitude of writers, who have treated on the ſtomach of ruminating animals, and its functions, I refer to the following only, on account of the plates which they have given, particularly ſuch as exhibit the vaſt increaſe of ſize

The firſt ſtomach, or *paunch*, (*rumen*, *penula*, *magnus venter*, *ingluvies*), is by far the largeſt in the adult animal; not ſo however in the recently born calf or lamb. It is divided externally into two ſaccular appendices at its extremity, and it is ſlightly ſeparated into four parts on the inſide. Its internal coat is beſet with innumerable flattened papillæ [17].

This

ſize in the firſt ſtomach compared with the fourth, in the early periods of life.

Obſerv. Anat. Collegii privati Amſtelodamenſis, pl. 1. p. 12.

PERRAULT, *Eſſais de Phyſique*, vol. 3. p. 211.

J. C. PEYER, *Merycologia*, Baſil. 1685, 4to.

J. J. HARDERI *Apiarium*, ib. 1687, 4to. p. 16.

DAUBENTON, tom. 4. tab. 15—18.

To which may be added, Mr. HOME's obſervations on the camel's ſtomach; which contain two excellent views of the cow's ſtomach by Mr. Clift, beſides thoſe of the camel. *Philoſ. Tranſ.* 1806, pl. 15, 16.

[17] It is generally in this firſt ſtomach, ſeldom in the ſecond, that morbid concretions are formed, of a globular, or elongated but yet rounded figure. They are compoſed of three kinds of ſubſtance: viz. of hairs, of the undigeſted fibrous parts of plants, or of ſtony matters.

The hair-balls, particularly in the cow, are formed of the animal's own hair, which is licked off, and gradually accumulated in the ſtomach. Theſe either retain a hairy appearance externally, or they are covered with a dark poliſhed ſubſtance, ſimilar to that which accumulates round their molar teeth. (See § 23).

The balls of the *chamois* (*ægagropilæ*), conſiſting of vegetable matters, particularly of the macerated fibres of the *æthuſa meum*, are found in the animals from which they de-

This is followed by the ſecond ſtomach, *honey-comb bag*, *bonnet*, or *king's-hood*, (*reticulum*, *ollula*), which may be regarded as a globular appendage of the paunch; but is diſtinguiſhed from the latter part by the elegant arrangement of its internal coat, which forms polygonal and acute-angled cells, or ſuperficial cavities.

The third ſtomach, which is the ſmalleſt, is called the *manyplus*, which is a corruption of *manyplies* (*echinus*, *conclave*, *centipellio*, *omaſum*): it is diſtinguiſhed from the two former, both by its form, which has been compared to that of a hedge-hog when rolled up, and by its internal ſtructure. Its cavity is much contracted by numerous and broad duplicatures of the internal coat, which lie lengthwiſe, vary in breadth in a regular alternate order, and amount to about 40 in the ſheep, 100 in the cow.

The fourth, or the *red*, (*abomaſum*, *faliſcus*, *ventriculus inteſtinalis*), is next in ſize to the paunch,

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rive their name, and are generally of a fine ſpongy texture, covered externally with a ſmooth black coat.

Of the ſtony concretions, which conſtitute the *bezoars*, the oriental ones are derived from the *wild goats*. Others come from the South American ſpecies of camel. The latter are of a yellow-grey colour; the former of a greeniſh-black, with concentrical ſtrata, and generally containing for a nucleus a ſmall bit of rice-ſtraw.

In a large *oriental bezoar*, which I ſawed through, the nucleus conſiſts of a red-brown, fine but compact, ſpongy ſubſtance, like that of the vegetable balls.

paunch, of an elongated pyriform ſhape, with an internal villous coat like that of the human ſtomach, with large longitudinal rugæ.

§ 90. The three firſt ſtomachs are connected with each other, and with a groove-like continuation of the œſophagus, in a very remarkable way. The latter tube enters juſt where the paunch, the ſecond and third ſtomachs approach each other; it is then continued with the groove, which ends in the third ſtomach. This groove is therefore open to the firſt ſtomachs, which lie to its right and left. But the thick prominent lips, which form the margin of the groove, admit of being drawn together ſo as to form a complete canal: which then conſtitutes a direct continuation of the œſophagus into the third ſtomach.

§ 91. The functions of this very ſingular part will vary, according as we conſider it in the ſtate of a groove, or of a cloſed canal. In the firſt caſe, the graſs, &c. is paſſed after a very ſlight degree of maſtication, into the paunch, as into a reſervoir. Thence it goes in ſmall portions into the ſecond ſtomach, from which, after a further maceration, it is propelled, by a kind of antiperiſtaltic motion, into the œſophagus, and thus returns into the mouth. It is here ruminated, and again ſwallowed, when the groove[18] is ſhut, and the morſel of food, after this ſecond maſtication, is thereby conducted directly into the third ſtomach[19]. During the ſhort time, which it probably ſtays in this ſituation between the folds of the internal coat, it is ſtill further prepared for digeſtion, which proceſs is completed in the fourth or true digeſtive ſtomach[20]. See note (E).

§ 92.

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[18] This ſuppoſes a power of voluntary motion in the part. And indeed the influence of the will in the whole affair of rumination, is inconteſtable. It is not confined to any particular time, ſince the animal can delay it according to circumſtances, when the paunch is quite full. It has been expreſsly ſtated of ſome men, who have had the power of ruminating, (inſtances of which are not very rare,) that it was quite voluntary with them. I have known two men, who ruminated their vegetable food: both aſſured me that they had a real enjoyment in doing this, which has alſo been obſerved of others: and one of them had the power of doing it, or leaving it alone, according to circumſtances.

[19] Theſe facts were underſtood by Severino, who ſays in his inſtructive *Zootomia Democritea* "A penula et ollula media revomitur ad os, hinc ruminatum ad conclave deſcendit, et hinc poſtremo ad ventriculum propriè dictum."

[20] I have already, on another occaſion, obſerved that the final purpoſe of rumination, as applicable to all the animals, in which it takes place; and the chief utility of this wonderfully complicated function in the animal economy, are ſtill completely unknown; what has been already ſuggeſted on theſe points, is quite unſatisfactory.

Fabricius ab Aquapendente has ſufficiently refuted the old dream of Aristotle and Galen; that rumination ſupplies

§ 92. There are ſtill two peculiarities in the ſtomachs of ſome mammalia, which muſt be mentioned here, before we proceed to conſider that of birds. (For the account of the camel's ſtomach, ſee note **, at the end of the chapter.)

In the *opoſſum*, the two openings of the ſtomach are placed as near, or even nearer together than in many birds; contrary to the uſual rule, in this claſs of animals.

There is a peculiar glandular body at the upper orifice of the *beaver*'s ſtomach, about the ſize of a florin, full of cavities, that ſecrete mucus. It reſembles, on the whole, the *bulbus glanduloſus* of birds; and aſſiſts in the digeſtion and animalization of the dry food, which this curious animal takes, conſiſting chiefly of the bark and chips of trees, &c. See note (F).

The ſtomach of the *pangolin (manis pentadactyla)* is almoſt as thick and muſcular as that of the gallinaceous fowls, and contains, like that of granivorous birds,

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plies the place of inciſor teeth, the materials of which, are applied, in theſe animals, to the formation of horns. PERRAULT and others ſuppoſed, that it contributed to the ſecurity of theſe animals, which generally eat much, and are timid, by ſhewing the neceſſity of their remaining long employed in chewing, in an open paſture. But the *Indian buffalo* ruminates, although it does not fly even from a lion, but rather attacks, and often vanquiſhes that animal. And the *wild goat* dwells in Alpine countries, which are inacceſſible to beaſts of prey.

birds, ſmall ſtones and gravel, which are probably ſwallowed, for the ſame purpoſe, as in thoſe birds[1]. See note (G).

(B) Birds.

§ 93. As we have ſpoken above of the *cheek-pouches* of ſome mammalia, we muſt here take notice of the *throat ſack*, which is found in the male[2] *buſtard*, under the integuments of the front of the neck; and opens by a wide aperture under the tongue: its uſe has not been hitherto diſcovered[3]. See note (N).

§ 94. The œſophagus, which generally deſcends on the right of the trachea, as well as its opening into the ſtomach, is of immenſe ſize in many carnivorous birds; conſiderably larger indeed than the inteſtinal canal. The capaciouſneſs of this tube, enables it hold for a time[4] the entire fiſh, and large bones, which theſe birds ſwallow, and which cannot be contained in the ſtomach; and to facilitate the diſcharge, by vomiting the indigeſtible remains of the food, which form balls of hair, feathers, and bony matter. See note (I).

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[1] That is to ſay, they are not ſwallowed, as Burt ſuppoſed, in the 2d vol. of *Aſiatic Reſearches*, to afford nouriſhment; but in order to kill and bruiſe the inſects, &c. which form the ordinary food of the animal, and which might otherwiſe, by means of their vitality, reſiſt the chemical action of the gaſtric juice; as the *inteſtinal worms* and *water-newts*, which have been ſwallowed, do in man and other mammalia.

[2] The late Dr. Bloch ſuppoſed, that he had found this part in the female bird. This was probably a miſtake; for I have lately examined a female buſtard, in which there was no trace of the part.

[3] Edwards's *Natural Hiſtory of Birds*, tom. 2. tab. 73. and Schneider, *Comment. ad reliqua Librorum, Frider. 2ndi*, p. 9.

§ 95. The œſophagus expands juſt before the ſternum into the *crop (ingluvies, prolobus, le jabot)*, which is furniſhed with numerous mucous, or ſalivary glands, diſpoſed in many caſes in regular rows. In ſuch birds, as nouriſh their young from the crop, the glands ſwell[5] remarkably at that time, and ſecrete a greater quantity of fluid[6]. This part is found in *land birds* only, but not in all of theſe; it exiſts in all the *gallinæ*, and in ſome birds of of prey[7]. See note (K).

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[4] A *ſea-gull*, which I kept alive for ſome years, could ſwallow bones of three or four inches in length, ſo that the lower end only reached the ſtomach, and was digeſted, whilſt the reſt projected into the æſophagus, and deſcended gradually, in proportion as the former was diſſolved.

[5] HUNTER *on the Animal Economy*, p. 193.

[6] This takes place in an inverſe ratio to the age of the young pigeon, as long as the old birds keep their food in the *crop*. See *Viridet du bon Chyle, pour la Production du Sang*, t. 1. p. 78.

[7] See WOLF, in VOIGT's *Magazine*, vol. 1. p. 72.

§ 96. There is another glandular and ſecretory organ, much more common than the crop, belonging indeed moſt probably * to the whole claſs. This is the *bulbus glanduloſus (echinus, infundibulum, proventriculus, corpus tubuloſum)*, which is ſituated before the entrance of the œſophagus into the proper ſtomach, and whoſe form and ſtructure vary conſiderably in the different genera and ſpecies. In the *oſtrich*, for example, its magnitude and form give it the appearance of a ſecond ſtomach[8]. In ſome other birds, as the *pſittaci, ardeæ* (crane, ſtork, &c.), its appearance is different from that of the proper ſtomach, but its ſize is larger; while, on the contrary, in gallinaceous fowls, it is much ſmaller[9]. See note (L).

§ 97. In moſt birds, the ſtomach lies at the upper[10] part of the abdomen, that is, cloſe to the ſpine, and reſts, in a manner, on a ſtratum of inteſtines; in the *cuckoo*, on the contrary, it lies below. This peculiarity does not, however, belong excluſively to that curious bird[11]; for I have found it in the *ramphaſtos*, and the *corvus caryocatactes* (the nut-cracker).

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* It appears, however, that the bulbus glanduloſus is wanting in ſome birds, as the *king's-fiſher*.

[8] Hence Valisnieri calls it in this animal, "*the firſt ſtomach*;" ſee his "*Anatomy of the Oſtrich*," in Italian, 1713, p. 159.

[9] For an account of ſeveral other variations in the ſtructure of this part, in different birds, ſee the Pariſian "*Mémoires pour ſervir a l'Hiſtoire Naturelle des Animaux.*"

[10] See note 1. § 40.

A deviation from the natural ſtructure, which is completely unparalleled, occurs in the ſtomach of the cuckoo. The gizzard of this bird is covered internally with an abundance of ſhort, briſtly, and ſpiral hairs, lying cloſe together.

§ 98. The ſtructure of the ſtomach differs moſt widely in the different orders and genera of this claſs. It appears merely as a thin membranous bag, in ſeveral of thoſe which feed on fleſh and inſects, when compared with the thick muſcular globes of the granivorous genera. But there are both many intermediate links[12] between theſe extremes, and at the ſame time conſiderable analogies in the ſtructures, which are apparently the moſt oppoſite. This is particularly obſervable, in the courſe of the muſcular fibres[13], and in the callous ſtructure and appearance of the internal coat[14]; in which points, many of what are called membranous ſtomachs, have a great reſemblance to thoſe of the *gallinæ*.

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[11] HERISSANT thought this circumſtance peculiar to the *cuckoo;* and hence explained, why that bird does not incubate. *Mem. de l'Acad. des Sc.* 1755.

[12] HALLER has collected a Number of theſe in his *Element. Phyſiolog.* t. 7. p. 115.

[13] DUVERNEY, *Oeuvres Anatomiques*, tom. 2. p. 447.

[14] WEPFER, *Cicutæ Aquaticæ Hiſtoria et Noxæ*, p. 174. This is, on the whole, a moſt inſtructive work in this branch of zootomy.

§ 99. Both parts, but particularly the muſcular, are very ſtrong in the gizzard *(ventriculus bulboſus)* of granivorous birds[15]. We find here, inſtead of a muſcular coat, four immenſely thick and powerful muſcles: viz. A large hemiſpherical pair at the ſides *(laterales)*, and two ſmaller ones *(intermedii)* at the two ends of the cavity. All the four are diſtinguiſhed, both by the unparalleled firmneſs of their texture[16], and by their peculiar colour, from all the other muſcles of the body.

The internal callous coat muſt be conſidered as a true *epidermis;* ſince, like that part, it becomes gradually thicker from preſſure and rubbing[17]. It forms folds and depreſſions towards the cavity of the ſtomach: and theſe irregularities are adapted to each other on the oppoſed ſurfaces. The cavity of this curious ſtomach, is comparatively ſmall; its lower orifice is placed very near the upper. Every part of the organ is, indeed, calculated for producing very powerful trituration[18]; and this is ſtill further promoted, by the well-known inſtinctive practice of granivorous birds, of ſwallowing ſmall hard ſtones with their food[19].

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[15] J. C. PEYER, *Anatome Ventriculi Gallinacei*, in his *Exercit. de Glandulis Inteſtinor.* Scafhus. 1677, 8.

[16] W. G. MUYS, *De Carnis Muſculoſæ Structurâ.* Leid. 1741. 4to. tab. 1.

[17] MONRO's *Eſſay on Comparative Anatomy.*

C. AMPHIBIA.

§ 100. The capacious œſophagus of the turtle, has a very ſtriking peculiarity in its ſtructure: its internal coat is beſet with [1] innumerable large, firm, and pointed proceſſes of a white colour. Their points are all directed towards the ſtomach; and they probably ſerve to prevent the return of the food, which can only enter the ſtomach gradually.

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[18] The numerous experiments, which REAUMEUR performed, in order to determine the extent of this triturative power, are univerſally known. There are two curious obſervations on this ſubject, leſs generally known. FELIX PLATER found an *onyx*, which had been ſwallowed by a hen, to be diminiſhed by one-fourth in four days; and a *Louis d'or* loſt in this way 16 grains of its weight. See SWAMMERDAM, *Biblia Naturæ*, p. 168.

[19] The end and uſe of ſwallowing theſe ſtones, have been very differently explained. CÆSALPINUS conſidered it rather as a medicine than as a common aſſiſtance to digeſtion. BOERHAAVE, as an abſorbent, for the acid of the ſtomach. REDI, as a ſubſtitute for teeth. According to WHYTT, it is a mechanical irritation, adapted to the callous and inſenſible nature of the coats of the ſtomach. SPALLANZANI rejected all ſuppoſition of deſign or object, and thought that the ſtones were ſwallowed from mere ſtupidity. I think there is not much ſagacity to be diſcovered in this opinion, when we conſider that theſe ſtones are ſo eſſential to the due digeſtion of the corn, that birds grow lean without them, although they may be moſt copiouſly ſupplied with food. This paradoxical opinion has, however, been already refuted by J. HUNTER, in his "*Animal Economy*," p. 155.; and G. FORDYCE, *on Digeſtion*, p. 23.

§ 101. The œſophagus of the *crocodile* is of the funnel ſhape; the ſtomach of the animal reſembles, although not very cloſely, that of the granivorous birds, in the nearneſs of its two apertures, and the thickneſs of its coats.

§ 102. The ſtomach of ſerpents can hardly be diſtinguiſhed from the œſophagus, except that it is ſomewhat larger. It is very ſhort, when compared with the great length of that tube. (See note (M).

(D) FISHES.

§ 103. The œſophagus is ſhort in moſt of this claſs. But this character is not univerſal, as ARISTOTLE

The uſe of ſwallowing theſe ſtones, ſeems to me, to conſiſt in this, that they kill the grain, and deprive it of its vitality, which otherwiſe reſiſts the action of the digeſtive powers. (See § 92, note 1.) Thus it has been found, that if the oats and barley given to horſes, are previouſly killed by heating, the animal only requires half the quantity, and yet thrives equally.

[1] RUYSCH, *Theſaurus Anatomicus*, 8vo. tab. 2.

TOTLE ſuppoſed[2]; nor is a long œſophagus peculiar to fiſhes of an elongated form. (See note (N).

§ 104. The ſize and form of the ſtomach vary[3] very conſiderably in this claſs. Its coats are thin in moſt fiſhes; but in ſome they are very thick and muſcular[4], and have a callous internal covering: ſtill, however, the reſemblance between theſe and the ſtomachs of granivorous birds is very remote.

(E) INSECTS.

§ 105. I have already obſerved, on another occaſion[1], that the buſineſs of nutrition in inſects, does not ſeem to have for its object, the mere preſervation of the individual, as in moſt red-blooded animals; but chiefly the conſumption of organiſed matter; which will appear clearly, from conſidering the ſtructure of their alimentary canal. In moſt of thoſe, which are ſubject to a metamorphoſis, the ſtomach, in the larva ſtate, is of a great ſize, in

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[2] See FABRICIUS AB AQUAPENDENTE, p. 101. of the edition quoted above.

[3] Repreſentations of the ſtomach of ſeveral fiſhes, may be ſeen in the 2d vol. of COLLINS's *Syſtem of Anatomy*. Lond. 1685, and in the "*Mémoires preſentés*," &c. by VICQ D'AZYR.

[4] RONDELET, p. 70.

[1] In the "*Manual of Natural Hiſtory*," in German, p. 298. edition 6th.

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compariſon with the ſhort inteſtinal canal: while thoſe on the contrary, which take little or no nouriſhment in their perfect ſtate, have this organ remarkably diminiſhed, and as it were contracted [2].

§ 106. Our limits will allow us to take but little notice here of the endleſs varieties, and peculiarities of internal ſtructure, which occur in the different genera and ſpecies of this multiform claſs of animals. We ſhall therefore only beſtow two words [3] on thoſe of the œſophagus and ſtomach. In ſeveral caſes, the commencement and termination of the alimentary canal, the œſophagus and rectum, are ſurrounded by an anular portion of the ſpinal marrow.

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[2] Compare, for inſtance, the ſtomach of the larva of the *papilio urticæ*, with that of the perfect *butterfly*, in SWAMMERDAM, *Biblia Naturæ*, tab. 34. fig. 4. and tab. 36. fig. 1.

[3] There are ſeveral delineations of the ſtomach, in the different orders of this claſs, viz. that of the *ſcarabæus naſicornis*, in SWAMMERDAM, tab. 27. Of the *earth-beetle*, in RÖSEL, vol. 2. tab. 8. Of the ſtag-beetle *(lucanus cervus)*, ibid. tab. 9. Of the *earwig*, in C. F. POSSELT, *Tentamina circa Anatomiam forficulæ Auriculariæ*. Jen. 1800, 4to. fig. 26. Of the *gryllus verrucivorus*, in RÖSEL, vol. 2. tab. 9. Of the *ſilkworm*, in MALPIGHI, *de Bombyce*, 1669, 4to.; in RÖSEL, vol. 3. tab. 9.; and BIBIENA, in the *Comment. Inſtit. Bonon.* tom. 5. part 1. tab. 2 and 3. Of the *coſſus*, in LYONET's chef d'œuvre, "*Anatomie de la Chenille*," &c. Of the *ephemera horaria*, in SWAMMERDAM, tab. 15. Of the larva of the *muſca chamæleon*, ibid. tab. 41. Of the *muſca putris*, ibid. tab. 43. Of the *louſe*, ibid. tab. 2.

In the earwig *(forficula auricularia)*, the upper orifice of the ſtomach is furniſhed with two rows of teeth [4].

In ſome of the *grylli* (graſshoppers), the ſtomach itſelf is ſmall, but the œſophagus much larger.

In ſome ſpecies of that genus, particularly in the *gryllus gryllotalpa*, the ſtomach conſiſts of three or four veſicular portions [5], which have been compared with the ſtomachs of the ruminating mammalia [6].

We have already (§ 1, note 1.) mentioned the ſtomach of the *lobſter*, and ſome other ſpecies of the genus *cancer* [7]; which is provided with ſeveral portions of bone. It contains alſo three teeth, which, together with the ſtomach itſelf, are annually reproduced, at leaſt in the *craw-fiſh (cancer aſtacus)*. (See note (O).

(F) VERMES.

§ 107. We can only ſelect a few inſtances [1], as examples of this claſs, which includes a great number of creatures, differing widely from each other.

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[4] POSSELT, in the work above quoted, p. 27. fig. 27.

[5] CUVIER, in the *Mémoires de la Societé d' Hiſt. Nat. de Paris*, an. 7. tab. 4.

[6] SWAMMERDAM, *Algem. Verhandel. van de Bloedelooſe Dierkens.* Utrecht, 1769, 4to.; and G. H. VELSCHII, *Hecatoſtea Obſ.* Aug. Vind. 1675, 4to. p. 71.

[7] See WILLIS, *De Anima Brutorum*, for a repreſentation of this in the *craw-fiſh*. Alſo RÖSEL, vol. 3. tab. 58.

[1] The following zootomiſts have given us repreſentations of

The *aphrodite aculeata* (ſea-mouſe), which is well-known, on account of its beautiful colours, poſſeſſes a very remarkable ſtomach. The form and ſize of the viſcus, reſemble thoſe of a date, while in ſtrength and compactneſs of texture, it approaches to that of granivorous birds[2].

The œſophagus is expanded into a *crop* in many *teſtacea*, particularly among the *bivalves*; and it is covered internally with numerous ſmall teeth[3].

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of the ſtomach, in the different orders of *vermes:* viz. TYSON, of the round worm *(lumbricus teres, aſcaris lumbricoides)*, in the *Philoſ. Tranſ.* vol. 13. No. 137; which may be compared with WERNER, *Vermium Inteſtin. Expoſitio.* Lipſ. 1782. tab. 7. WILLIS, of the *earth-worm*, tab. 4. Alſo VANDELLI, *Diſſ. de Aponi Thermis*, &c. Patav. 1758, 8vo. MORAND, of the leech, in the *Mem. de l'Acad. des Sc.* an. 1739. As well as BIBIENA, in the *Comm. Inſtit. Bonon.* tom. 7, p. 102. Of the *ſlug*, SWAMMERDAM, tab. 9. Of the *cuttle-fiſh*, ibid. tab 51. As alſo MONRO, *On the Phyſiology of Fiſhes*, tab. 31. POLI, of ſeveral teſtacea, in his "*Teſtacea utriuſque Siciliæ,*" viz. the *pholas dactylus*, tom. 1, tab. 7.; the *tellina planata*, tom. 1. p. 14. *Mactra Neapolitana*, tom. 2. tab. 19.; the *venus chione*, tab. 20. Of the *ſnail*, SWAMMERDAM, tab. 5. Of the *ſea hedge-hog (echinus eſculentus)*, MONRO, tab. 32.

[2] See PALLAS, *Miſcellanea Zoologica*, tab. 7.

[3] For inſtance, in the *chiton cinereus*, ſee POLI, tom. 1. tab. 3. Compare alſo the œſophagus of the *cuttle-fiſh*, which is furniſhed with teeth in the ſame manner. See TURBERVILLE NEEDHAM's "*Nouvelles Obſervations Microſcopiques,*" tab. 3.

The powerful ſtomach of the *bulla lignaria*, contains three hard calcareous ſhells, by which the animal is enabled to bruiſe and maſticate the other teſtacea, on which it feeds[4].

In moſt of the proper *molluſca*, the ſtomach is of a ſimple membranous ſtructure, and of very different comparative magnitudes. I have found it very large in the *ſcyllæa pelagicum*. It occupies the greateſt part of the body in the *leech*, and is divided internally by means of ten imperfect partitions, into ſomewhat ſeparate portions.

Laſtly, the armed polypes *(hydra)*, and other ſimilar *zoophytes*, can hardly be conſidered as any thing more than a mere ſtomach, having its opening furniſhed with tentacula. (See note (P) at the end of the chapter.)

Additional Notes to the Sixth Chapter.

(A) A cheek-pouch exiſts alſo in the *ornithorhynchus paradoxus*. Phil. Tranſ. 1800, part 1, tab. 2. fig. 2.

The *ſalivary glands* of the mammalia exhibit very few variations in ſtructure. They are ſmall in the *carnivora*, as maſtication, properly ſo called, can hardly be ſaid to take place in them. On the contrary, the *ruminantia* and *ſolipeda* have them very large. The ſize of the ſub-maxillary gland, in particular, is remarkable in the *cow* and *ſheep*: it extends along the ſide of the larynx, quite to the back of the pharynx.

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[4] Draparnaud, in the new *Journal de Phyſique*, tom. 7. p. 146. This ſtomach, was lately taken by ſome naturaliſts, for a peculiar genus, of an entirely new order of *three-ſhelled teſtacea*.

The parotid and ſublingual glands do not exiſt in the *amphibious mammalia*, as the *ſeal*: the teeth of that animal are only adapted for ſeizing their prey, and muſt be utterly incapable of maſtication. The ſame remark may be made on the *cetacea*, where the ſalivary ſyſtem ſeems to be altogether deficient.

The mucous glands, which conſtitute the *labiales* and *buccales* of man, are larger and more diſtinct in ſome animals. There is a row of theſe oppoſite to the molar teeth of the *dog* and *cat*, penetrating the membrane of the mouth by ſeveral ſmall openings. Thore is alſo a conſiderable gland in the *dog*, under the zygoma, and covered by the maſſeter. Its duct, equal in ſize to that of the parotid, or ſub-maxillary glands, opens at the poſterior extremity of the alveolar margin of the upper jaw. The molar glands and their openings, are very conſpicuous in the *pig*. The *cow* and *ſheep* have an aſſemblage of ſimilar glands in the zygomatic foſſa: their excretory ducts open behind the laſt ſuperior molar tooth.

(B) No mammalia poſſeſs an uvula, except *man*, and the *ſimiæ*. As the *cetacea* poſſeſs no noſtrils, they have not of courſe any velum palati.

The parts about the pharynx exhibit a very ſingular ſtructure in theſe animals. The larynx is elongated, ſo as to form a pyramidal production, on the apex of which, its opening is found. The projection of this part will divide the pharynx; and the food muſt paſs on either ſide of the pyramid. A muſcular canal extends from the pharynx to the blowing holes, and is attached to the margin of thoſe apertures. The circular fibres of this tube, form a ſphincter muſcle; which, by contracting round the pyramid, cuts off the communication between the blowing holes and the mouth and pharynx.

(C) In the animals alluded to in this paragraph, the left half of the ſtomach is covered with cuticle, while the other portion has the uſual villous and ſecreting ſurface. The cuticular covering, forms amore or leſs prominent ridge at its termination. The left portion of the cavity may be regarded as areſervoir, from which the food is tranſmitted to the true digeſtive organ; and the different ſtates, in which the food is found in the two parts of the cavity, juſtify this ſuppoſition. Hence theſe ſtomachs form a connecting link between thoſe of ruminating animals on one ſide; and ſuch as have the whole ſurface villous, on the other.

(D) The larvæ of the *æſtrus equi* (the *large horſe-bot)*, attach themſelves to every part of the ſtomach, but are in general moſt numerous about the pylorus; and are ſometimes, but much leſs frequently, found in the inteſtines. They hang moſt commonly in cluſters, being fixed by the ſmall end to the inner membrane of the ſtomach, where they adhere, by means of two ſmall hooks, or tentacula. When removed from the ſtomach, they will attach themſelves to any looſe membrane, and even to the ſkin of the hand; for this purpoſe, they draw back their hooks almoſt entirely within the ſkin, till the two points of theſe hooks come cloſe to each other; they then preſent them to the membrane, and keeping them parallel till it is pierced through, they expand them in a lateral direction; and afterwards, by bringing the points downwards, or towards themſelves, they include a ſufficient piece of the membrane with each hook, and thus remain firmly fixed, for any length of time, without any further exertion of the animal. They attain their full growth about the latter end of May, and are coming from the horſe from this time to the latter end of June. On dropping to the ground, they ſoon change to the *chryſalis*, and in ſix or ſeven weeks the fly appears. This bot is larger and whiter than that of the *æſtrus hæmorhoidalis*, *morrhoidalis*, which has a reddiſh caſt; but in its ſtructure, and ſituation in the animal, reſembles the former. It is found, however, to hang about the rectum, previouſly to quitting it, which the large horſe-bot never does.

Veterinary practitioners do not ſeem to have decided hitherto, whether theſe animals are prejudicial to the horſe; nor even whether they may not be actually beneficial. Their almoſt univerſal exiſtence at a certain ſeaſon, even in animals perfectly healthy, ſhews that they produce no marked ill effect: yet the holes which they leave, where they were attached to the ſtomach, could hardly be made, without cauſing ſome injurious irritation.

For the mode, in which theſe bots gain admiſſion into the ſtomach, as alſo for a moſt intereſting general account of their hiſtory and ſtructure, ſee REES's *Cyclopædia*, art. BOTTS; which was furniſhed by Mr. CLARKE, and from which the preceding account is borrowed.

(E) The food of carnivorous animals approaching in its conſtituent elements more nearly to thoſe of the animal, than that of the herbivorous tribes; is more eaſily reduced into the ſtate, which is required for the nouriſhment of the body, in the former than in the latter caſe. Hence ariſes a leading diſtinction between the ſtomachs of theſe claſſes. In the latter animals, the œſophagus opens conſiderably to the right of the great extremity, ſo as to leave a large cul de ſac on the left ſide of the ſtomach; and the ſmall inteſtine commences near the cardia, leaving a ſimilar blind bag on the right. The food muſt be detained for a long time in ſuch a ſtomach, as the paſſage from the œſophagus, to the pylorus is indirect and highly unfavourable to ſpeedy tranſmiſſion. Animals of the *mouſe kind*, and the *rodentia* ſhew this ſtructure very well; it is very remarkable in the *mus quercinus*, (CUVIER *Léçons*, &c. tom. 5. pl. 36. fig. 11.) In the *carnivora*, the ſtomach, which is of a cylindrical form, has no cul de ſacs; the œſophagus opens at its anterior extremity, and the inteſtine commences from the poſterior; ſo that every thing favours a quick paſſage of the food. Animals of the *weaſel* kind, which are very truly carnivorous, exhibit this ſtructure the moſt completely. The *ſeal* alſo exemplifies it; and the *lion*. (CUVIER, pl. 36. fig. 7).

(**) The peculiar ſtructure of the ſtomach in the *camel* and *lama*, which enables theſe animals to take at one time a ſufficient quantity of water to laſt them for two, three, or more days, and thereby renders them adapted to inhabit the dry and ſandy deſerts, which conſtitute their natural abode, has been entirely omitted by the author. The fluid, which they drink, is depoſited in numerous cells formed in the ſubſtance of their firſt and ſecond ſtomachs, by ſtrong bands of muſcular fibres croſſing each other at right angles. It ſhould ſeem that the animal has the power of cloſing theſe cells, by the contraction of thoſe fibres which form the mouths of the cavities; or of expelling the contained fluid by putting the other portions of fibres in action.

This cellular ſtructure is found in two parts of the firſt ſtomach; and it occupies the whole of the ſecond. It was found in a dead camel, that theſe cavities would hold two gallons of fluid: but they were probably more capacious during life, as the animal in queſtion always drank ſix or ſeven gallons of water every other day, and took more in the intermediate time. Mr. Bruce ſtates in his travels, that he procured four gallons from one which he ſlaughtered in Upper Egypt. (Shaw's *Abridgment of Bruce's Travels*, ed. 3. p. 371).

As all the food which the animal takes paſſes into the firſt ſtomach, the water of the cells in that part becomes turbid; but it remains perfectly pure in the ſecond, where it reſides in the greateſt quantity: which circumſtance accounts for travellers being able to drink it on an emergency. The muſcular bands, which form the groove deſcribed at § 90, are particularly ſtrong; and by drawing the third ſtomach to the œſophagus, convey the ruminated food through the ſecond, without polluting the water in its cells. Hence the food that has been macerated in the paunch muſt be ſent back to the mouth directly from that cavity, without paſſing into the ſecond ſtomach, as it does in the *cow*. See "Obſervations on the camel's ſtomach, reſpecting the water which it contains," &c. by E. HOME, Eſq. Philoſ. Tranſ. 1806.

The cells are deſcribed and delineated, but very imperfectly, by the Pariſian diſſectors. *Deſcription Anatomiquè*, &c. p. 80.

The ſtructure of theſe parts in the *lama*, according to the account which CUVIER has given of them, from the examination of a fetus, does not ſeem to differ eſſentially from that of the camel.

Léçons d'Anat. Comp. tom. 3. p. 397.

Mr. HOME alſo deſcribes a projecting glandular body in the fourth ſtomach, near the pylorus, both in the cow and camel. He ſtates that it may ſhut that aperture. The ſame body is repreſented as very large in the lama, by CUVIER loc. cit.

(F) According to CUVIER, there is a gland, as large as the head of a man, ſituated between the the coats of the ſtomach in the *manati (tricheus manatus borealis)*. It is placed near the œſophagus, and diſcharges, on preſſure, a fluid like that of the pancreas by numerous ſmall openings.

Léçons d'Anat. Comp. tom. 3. p. 401.

Mr. HOME is of opinion, that a glandular ſtructure exiſts in the ſtomach of the *ſea-otter* near the pylorus. *Philoſ. Tranſ.* 1796. pl. 2. And Mr. MACARTNEY has diſcovered an arrangement of glandular bodies in the *dormouſe*, round the œſophagus juſt before its termination, ſimilar in ſituation and appearance to the gaſtric glands of birds.

(G) The ſtomach of the *ornithorhynchus hyſtrix* is covered with cuticle, and poſſeſſes ſharp horny papillæ near the pylorus. The animal ſwallows ſand, which may probably aſſiſt in the reduction of the food, as the gravel does, which is ſwallowed by the gallinaceous birds. HOME in the *Philoſ. Tranſ.* 1802. p. 2.

(H) A very remarkable dilatation of the fauces occurs in the *pelican*. An immenſe pouch, capable of holding ſeveral quarts of water, lies between the branches of the lower mandible, and conſtitutes a reſervoir for the food, which conſiſts of fiſhes. By means alſo of this bag, the animal feeds its young, until they are of ſufficient ſtrength to provide for themſelves.

(I) Proper ſalivary glands, ſuch I mean, as ſecrete that clear and limpid fluid conſtituting the ſaliva, do not exiſt in birds. For maſtication, or the comminution of the food, and its reduction into a ſoft paſte, to which function theſe glands are entirely ſubſervient, is not performed in the mouth of theſe aniamls, but in their gizzard. Birds however have a very copious apparatus of thoſe mucous follicles, which form the glandulæ labiales, buccales, linguales, &c. of the human ſubject. The ſides of the tongue, the under ſurface of that organ, and the entrance of the œſophagus, are beſet with numerous openings of theſe glands, which furniſh an abundant ſupply of viſcid mucus to defend the tender lining of theſe parts from the hard bodies, which conſtitute the food of ſeveral birds. Theſe apertures are very conſpicuous in the gallinæ. The *oſtrich* in particular, has two flattened bodies at the upper and back part of the palate, which may be compared in ſome reſpects to tonſils. The ſurface of theſe is covered with innumerable foramina, from which a tenacious mucus may be expreſſed. The ſoft palate, &c. are entirely deficient in birds: the noſtrils open on the bony palate by longitudinal ſlits, the ſides of which are guarded by ſoft pointed papillæ.

(K) The crop of the *common fowl*, and of the other *gallinæ*, is of a globular form, and placed juſt in front of the cheſt. The œſophagus, which opens at its upper part, commences again about the middle of the bag, ſo that the crop itſelf forms a cul de ſac, or bag out of the regular courſe of communication between the two openings of the œſophagus. In the *pigeon* there is a ſpherical bag formed on both ſides of the œſophagus; which tube itſelf is very large in the *pouting pigeon*, and admits of being diſtended with air, ſo as to cauſe the appearance from which the name of the bird is derived.

In the birds, which we have now mentioned, the crop muſt be conſidered as an organ for macerating the dry and hard vegetable ſubſtances, which conſtitute the food of theſe animals. The *accipitres* alſo have this dilatation; but it muſt be regarded in them merely as a reſervoir for the food, which does not require any previous ſoftening. It is wanting in the piſcivorous birds; but its place is ſupplied by the great ſize of the œſophagus, in which entire fiſhes are held until they can paſs into the ſtomach. The *heron*, *cormorant*, &c. exemplify this.

(L) The term *bulbus glanduloſus* (*ventricule ſuccenturié*, CUVIER) is applied to a ſmall portion of the œſophagus, juſt before its termination in the ſtomach. This part is obviouſly rather larger and thicker in its coats than the reſt of the tube. Its ſtructure may be moſt clearly diſcerned in the gallinaceous genera. The œſophagus conſiſts, as in other parts, of its two coats, the muſcular and villous: but a vaſt number of *glandular bodies*, cylindrical in form, and arranged in cloſe appoſition to each other, are interpoſed between theſe tunics, and entirely ſurround the tube; conſtituting the "*zone of gaſtric glands*" of Mr. MACARTNEY, (REES's *Cyclopædia*, Art. BIRDS). Theſe bodies have a hollow internally, and they open into the cavity of the *bulbus*. The fluid ſecreted by them, which from their number and ſize, muſt be furniſhed

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in great abundance, paſſes into the gizzard, and mixes with the food in proportion as it is triturated by that organ. Theſe glands are much leſs diſtinct in thoſe birds which live on animal food, as the *accipitres*, and the *piſcivorous genera*, but they exiſt univerſally, and their openings can always be diſcerned. The *oſtrich* affords an opportunity of examining them to great advantage. In the *African* ſpecies, of which I diſſected an individual, the œſophagus was dilated into an immenſe bag, capable of holding ſeveral pints of water, and five or ſix times larger than the gizzard itſelf, which was placed on the right and anterior part of this dilatation. The glands did not ſurround the tube, ſo that the term of *zone* would be here inapplicable. They formed a long but narrow band, commencing at the termination of the œſophagus, and running along the front of the bag towards the gizzard. This band meaſured about twelve inches in length, and not more than three at its greateſt breadth. The ſize of the individual glands varied: they were largeſt in the middle, and decreaſed towards either margin of the band. Some of them equalled a large pea; and their openings were in proportion. They were arranged in cloſe appoſition to each other, and the inner ſurface of the pouch was covered by a continuation of the inſenſible lining of the gizzard, which ſeparated very eaſily from the ſurface.

(M) Reptiles reſemble birds in having their noſtrils terminate by two longitudinal ſlits on the palate; and in the want of velum palati, and epiglottis.

The œſophagus of the ſerpent kind is of immenſe magnitude; for theſe reptiles ſwallow animals larger than themſelves, which are retained for a conſiderable time in the tube, and deſcend into the ſtomach by degrees, where they are ſlowly ſubjected to the action of the gaſtric juice. The whole proceſs ſometimes occupies many days or even weeks.

(N) From the peculiar formation of the noſe of fiſhes; and from their reſpiring by means of gills, their fauces have no connection with any naſal cavity, or glottis.

The œſophagus is of great width in fiſhes; and is diſtinguiſhed with difficulty in many caſes from the ſtomach. Theſe animals ſwallow their food whole, without ſubjecting it to any maſtication; and if the ſtomach will not hold the whole, a part remains in the œſophagus, until that, which has deſcended lower, is digeſted. The alimentary canal is generally very ſhort; ſometimes extending ſtraight from the mouth to the anus with very little dilatation; as in the lamprey *(Petromyzon marinus)*.

(O) The cruſtacea, and ſome inſects, are furniſhed with organs of maſtication of ſimilar ſtructure. Their mouth is formed of two or more pairs of jaws placed laterally. Theſe move from without inwards, and vice verſâ; whereas thoſe of red-blooded animals move from above downwards, and back again. The parts, which are termed the lips of inſects, are two bodies; of which one is placed above or in front of the jaws, and the other below or behind them. The palpi or feelers are articulated to the jaws. All inſects, which have jaws, poſſeſs the power of maſticating hard animal and vegetable ſubſtances; for theſe parts are of a firm horny texture, and in many caſes are very large, when compared with the ſize of the animal.

The locuſts *(grylli)*, the dragon-fly *(libellula)*, the *beetles*, and particularly the *lucanus cervus*, or ſtag-beetle, and the *ſtaphylinus maxilloſus*, are examples in which the jaws are very large and manifeſt, and often poſſeſs denticulated edges. All the genera of the following orders have jaws; viz. the *coleoptera*, *orthoptera*, *neuroptera* and *hymenoptera*. The inſects of the remaining orders derive their nouriſhment chiefly from liquids; which they get either from animal or vegetable ſubſtances by means of a ſpiral and tubular tongue, or a ſoft proboſcis, (as in the *lepidoptera)*, with a broad opening, admitting of extention and retraction, (the *hemiptera*), or a horny pointed tube, containing ſharp briſtly bodies internally (the *diptera* and *aptera*).

The ſtomach of the *bee* is a tranſparent membranous bag, in which the nectar of the flowers is elaborated and converted into honey. The animal vomits it up from this reſervoir, and depoſits it in the hive.

The ſtomach of the *crab* and *lobſter* is a very ſingular organ. It is formed on a bony apparatus, in ſhort a ſpecies of ſkeleton; and does not therefore collapſe when empty. To certain parts of this bony ſtructure, round the pylonus, the teeth are affixed. Their ſubſtance is extremely hard, and their margin is ſerrated or denticulated: as they ſurround the tube, near the pylorus, nothing can paſs that opening, without being perfectly comminuted. Theſe bones and teeth are moved by peculiar muſcles.

(P) In thoſe molluſca, which poſſeſs jaws, theſe parts are fixed in the fleſh of the animal, as there is no head to which they can be articulated. They are two in number in the *cuttle-fiſh*, are compoſed of a horny ſubſtance, and reſemble exactly the bill of a parrot. They are placed in the centre of the lower part of the body, and are ſurrounded by the tentacula, which enable the animal to attach itſelf to any objects. By means of theſe parts, the ſhell-fiſh, which are taken for food, are completely triturated. The *common ſnail* and *ſlug* have a ſingle jaw, ſemilunar in its form, and denticulated. The *tritonia* has two jaws, which act like the blades of a pair of ſciſſars. The other *molluſca* poſſeſs no organs of this kind; but have, in ſome inſtances, a ſort of proboſcis; as the *buccinum*, *murex*, *voluta*, *doris*, *ſcyllæa*, &c.

In the *worms*, properly ſo called, there are ſometimes hard parts forming a kind of jaws or teeth. Thus in the *nereis*, the mouth poſſeſſes ſeveral calcareous pieces. The *aphrodite (ſea-mouſe)*, has a proboſcis, furniſhed with four teeth, which it can extend and retract at pleaſure. Within the mouth of the *leech* are three ſemicircular projecting bodies, with a ſharp denticulated edge: by this apparatus the animal inflicts its wound of the well-known peculiar form in the ſkin.

The teeth of the *echinus*, (ſea-hedgehog) are of a very ſingular arrangement; a round opening is left in the ſhell for the entrance of the food; a bony ſtructure, on which five teeth are placed, fills up this aperture; and as theſe parts are moved by numerous muſcles, they form a very complete organ of maſtication.

The ſtomach of the vermes is, in general, a membranous bag; but in ſome caſes its ſtructure is more complicated. In addition to the inſtances mentioned by the author, we may obſerve that the *helix ſtagnalis*, and the *onchidia*, have gizzards. The *aplyſia* has three ſtrong muſcular ſtomachs, provided with pyramidal bony proceſſes. This ſtructure, together with that of the *bulla lignaria*, and of the *lobſter* and *crab*, preſents a new analogy, as CUVIER has obſerved, between the membranes of the inteſtines, and the integuments of the body. This is particularly ſtrengthened by the annual ſhedding of the lobſter's teeth, when its cruſtaceous covering falls off.

CHAPTER VII.

ON THE INTESTINAL CANAL.

(A) MAMMALIA.

§ 108. THE inteſtinal canal (which is the moſt common part in the whole animal kingdom after the ſtomach), is diſtinguiſhed in this claſs, by two peculiarities, which depend on the mode of nutrition. It is comparatively ſhorter in *carnivorous animals*, and there is alſo in theſe, leſs difference to external appearance, between the ſmall and the large inteſtine, than in the *herbivora*. Yet theſe rules are not without their exceptions. For the *ſeal* has very long, and the *ſloth* very ſhort inteſtines; the *badger*, which is not a proper carnivorous animal, and ſeveral true *herbivora*, as, for inſtance, the *rell-mouſe (glis eſculentus)*, have no diſtinction between the large and ſmall inteſtine, &c. (See note (A) at the end of the chapter).

§ 109. The valvulæ conniventes of the ſmall inteſtine are more faintly marked in moſt mammalia than in man; in ſome indeed they do not exiſt at all, and this happens both in carnivorous and herbivorous animals. In the *cetacea*, on the contrary, the internal ſurface of the inteſtines has longitudinal folds of a zig-zag appearance.

The poſſeſſion of a villous coat for the abſorption of the chyle conſtantly diſtinguiſhes the ſmall from the large inteſtine, which ſeems to be merely deſtined for the reception of the fæces. The villi are remarkably long and numerous in the bear *.

The Fallopian valve *(valvula coli)* is wanting in a few animals only of this claſs, as, for inſtance, in the hedgehog [1].

§ 110. There is great variety with reſpect to the cæcum in this order, even in the different ſpecies of the ſame genus. Many, particularly of the *carnivora*, have none; it is alſo wanting in ſome herbivora, as the *rell-mouſe* In others of the latter deſcription, it is often of enormous ſize. Thus in the *hare* and *rabbit* it is longer than the whole animal, and furniſhed internally with a peculiar ſpiral valve. The *marmot of the cape* has firſt a large cæcum, and then, further on, two other conical blind appendices.

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* There is an account of the ſtructure of this villous coat, in ſeveral ſpecies of all the four claſſes of red-blooded animals, in R. A. Hedwig's *Diſquiſitio Ampullularum Lieberkühnii*, Lipſ. 1797, 4to. and in K. A. Rudolphi's *Anatomico Phyſiological Tranſactions*, in German, p. 41.

[1] Roederer gives an accurate deſcription of this valve in our domeſtic animals, "*De Valvulâ coli.*" Argent, 1768, 4to. p. 46.

The *appendicula vermiformis* is wanting in many mammalia; even in ſome of the ſimiæ. (See note (B) at the end of the chapter.)

§ 111. In moſt herbivorous animals of this claſs, the colon is large, long, and divided into cellular compartments. This is remarkably the caſe with the *elephant* and *horſe*. The large inteſtine of the latter is 24 feet long; while, on the contrary, in a moderate ſized dog it is about ſix or eight inches. The rectum of the latter has ſtrong tranſverſe folds which contract it, and render the evacuation of the fæces difficult.

In a few inſtances, as the *beaver* and *ſloth*, the rectum and urethra have a common termination, which may be compared to the cloaca of birds[2]. This

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[2] As we have ſpoken above of the *bezoars* and other concretions formed in the ſtomach, we muſt here take notice of the inteſtinal ſtones, which occaſionally occur in horſes, and of the valuable fecal concretions of the pikeheaded whale or cachalot. (*Phyſeter Macrocephalus*).

The former are commonly of a yellowiſh grey colour; of a globular form, ſhining externally, but of a dead and earthy appearance in their fracture; not very hard; and in their average ſize about equal to a billiard ball; although they have been found as large as a man's head: all theſe external characters vary indeed conſiderably. The moſt remarkable

This ſimilarity is however the moſt ſtriking in the cloaca of the ormithorhynchus. (Home in the Philoſ. Tranſ. for 1802, pl. 1.)

(B) Birds.

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remarkable circumſtance relating to them, is their compoſition; according to Fourcroy and Bartholdi they conſiſt in the proportion of one half, of phoſphate of magneſia. They are often found in millers' horſes, which have been fed for a long time with bran and mill-duſt; there is uſually only one, but ſometimes more; they are moſt frequent in the colon, and have very ſeldom been found in the ſtomach (at leaſt of the ſame ſort, which has been now deſcribed). They are not diſcovered in general until the death of the animal. But I find an inſtance, in the "*Epiſtolæ de Re Numiſmaticâ ad* Z. Goezium, of a horſe, which voided a ſtone of the above-mentioned kind, as large as a hen's egg, every month with his fæces.

A ſpecies of globular concretions, very different from theſe inteſtinal ſtones, is occaſionally found in the colon, and cæcum of the *horſe*. It is compoſed of fine vegetable fibres, and reſembles, on the firſt view, the balls of the *chamois*, (ſee note 17, § 89). Hence Lafosse, who has deſcribed and delineated them, calls them *ægagropilæ*, by way of diſtinction from the true inteſtinal ſtones, which he terms *bezoar equinum*, ſee his "*Cours d' Hippiatrique*." p. 158. tab. 51. Like the balls of the *chamois*, they are much lighter than inteſtinal ſtones; and two of them are not unfrequently found together, one being incloſed within the other.

The fecal indurations of the *cachalot* form the valuable ſubſtance, known by the name of *ambergris*, which was formerly conſidered as an animal excrement, but has been ſuppoſed latterly by ſome to be a foſſile ſubſtance, by others to be a vegetable reſin: its animal origin is now placed beyond all doubt. Sir Jos. Banks informed me, ſome time ago, that, according to what he could learn from the Engliſh South-

(B) BIRDS.

§ 112. The alimentary canal, in this claſs, is much ſhorter than in the mammalia; it is alſo generally ſhorter in carnivorous birds than in ſuch as derive their food from the vegetable kingdom. There is hardly any perceptible external difference between the large and ſmall inteſtine; indeed, the commencement of the canal is often larger than the termination.

§ 113. Moſt birds have two cæca, which are of conſiderable length in ſome ſpecies of the gallinaceous and aquatic birds. They are characterized in the oſtrich [3], by a remarkable ſpiral valve. Some few aquatic birds have only a ſingle cæcum; and ſome, particularly among the birds of prey, want it entirely.

§ 114. The rectum ends in a part called the cloaca; which is an expanded portion, containing the

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South-Sea whalers, the fæces of the cachalot, which are nearly fluid in a healthy ſtate, are hardened into this ambergris, by a kind of conſtipation; hence, it is only found in weak and exhauſted animals; and the firmeſt and moſt valuable, comes from ſuch as ſeem to have died of the complaint, which it has occaſioned.

[3] See VALISNIERI, *Anatomy of the Oſtrich*, tab. 2.

the terminations of the ureters, the genital organs, and the *burſa* FABRICII. This latter part varies in form in the different ſpecies, being oval, or elongated, &c.; it is largeſt in young birds, and is ſo contracted in older ones, that it will hardly hold a millet-ſeed [4] in an old cock. (For a further account of it, ſee note (C) at the end of the chapter).

(C) AMPHIBIA.

§ 115. We ſhall take only one ſpecies of each of the two chief diviſions of this claſs, by way of examples.

The inteſtinal canal of the hawkſbill turtle (*teſtudo caretta*), is five times as long as the whole animal; the ſmall inteſtine, as it is called, is larger than the ſhort portion of large inteſtine. Both portions have longitudinal [5] folds internally, and are covered with an abundance of mucus [6], (which is the caſe in the whole claſs).

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[4] DE GRAAF, *De Mulierum Organis Generat. Inſervientibus*, tab. 17.; and G. G. TANNENBERG, *Spicileg. Obſerv. circa Partes Genital. Maſculas Avium*, Gött. 1789, 4to. tab. 2 and 3.

[5] I found theſe folds, ſo large and numerous in the rectum, that a tranſvere ſection of the gut, preſented the appearance of a broad radiated ring.

[6] That portion of the ſmall inteſtine, which correſponds to the jejunum, was beſet, in the animal which I diſſected, with innumerable ſmall proceſſes, like the *appendiculæ epiploicæ*, which are occaſionally found in ſome mammalia.

§ 116. In the *coluber natrix*, the whole length of the inteſtinal canal does not equal that of the animal. The ſmall inteſtine forms a very conſiderable *fallopian valve*, by a prolongation at its entrance into the large. The termination of the ſmall, as well as the large inteſtine, the ſtomach, and œſophagus (which is one-third of the length of the whole animal) have longitudinal folds [7] internally.

(D) FISHES.

§ 117. The inteſtinal canal of this claſs, with a very few exceptions, is extremely ſhort. In ſome, as the *torpedo* [8], it is only half as long as the ſtomach. However, the paſſage of the chyle, and afterwards of the fæces, through the inteſtine, is lengthened in this, and ſome other cartilaginous fiſhes, by a ſpiral valve [9] *.

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[7] See CHARAS, *Nouvelles Experiences ſur la Vipére.* Par. 1672, 8vo.; and TYSON's *Anatomy of a Rattleſnake.* Philoſ. Tranſ. vol. 13, No. 144.

[8] LORENZINI, "*Obſervations relating to the Torpedo*," in Italian. Flor. 1678, 4to. tab. 2.

[9] It is delineated, from another ſpecies of *ray*, by SWAMMERDAM, in the 4th edition of BARTHOLIN's *Anatomy*. Lugd. Bat. 1673, p. 297; which contains much valuable information in zootomy. PERRAULT has repreſented it in a *ſhark*, *Eſſais de Phyſique*, v. 3.

* For an account of the ſtructure of the coats of the alimentary canal, ſee note (D) at the end of the chapter.

§ 118. The *appendices pyloricæ*, (which are found in all fiſhes, with a very few exceptions, as the *pike)* ſometimes open at the lower orifice of the ſtomach, but generally at the commencement of the inteſtinal canal, and ſecrete a fluid, which ſeems to have conſiderable influence on the buſineſs of digeſtion and chylification [10], which is performed in theſe animals in a very ſhort time. They have generally the appearance of ſmall blind appendices [11], and their number varies in the different ſpecies, from one to ſeveral hundreds. In ſome cartilaginous fiſhes, they are, as it were, conſolidated into a glandular body [12], which has been compared to the pancreas of warm-blooded animals.

(E) INSECTS.

§ 119. Similar blind appendices *(vaſa varicoſa* of SWAMMERDAM), are found on the ſhort alimentary canal of ſeveral inſects[13]; which is particularly diſtinguiſhed from that of red-blooded animals, by the want of meſentery[14].

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[10] The leading work, on this ſubject, is very rare, "*Pars altera Obſerv. Anat. Collegii privati, Amſtelod.*" which was produced almoſt entirely by SWAMMERDAM.

[11] In ſome, as the BURBOT, they appear almoſt like a finger. Hence the part has been called the *burbot*'s hand or foot. See CHR. ENCELIUS, *De Re Metallicâ.* Francof. 1551, p. 241; which contains, I believe, the firſt delineation of the part.

[12] The conſequences, which may be drawn from this circumſtance, towards the elucidation of the buſineſs of ſecretion, have been already pointed out in my *Inſtit. Phyſiol.* p. 367.

(F) Vermes.

§ 120. Several *molluſca* have theſe appendices on both ſides of their ſhort inteſtinal tube, viz. the *aphrodite aculeata.* Thoſe teſtacea, which remain fixed in one ſituation, have a ſhorter and more ſimple inteſtinal canal than thoſe which have the power of locomotion. The rectum, according to Poli, paſſes directly through the heart in moſt of the bivalves. In the ſlug *(limax)*, as well as in the ſimilar animal, which inhabits a ſhell *(helix)*, the rectum opens on the front of the *limbus*, cloſe to the air-hole. The *leech* can hardly be ſaid to poſſeſs an inteſtine; yet it has an anus at the end of the tail, from which ſome little fecal matter is diſcharged, moſt of this being evacuated by the mouth. The *armed polypes* have no opening of this kind *.

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[13] Some zootomiſts have conſidered theſe as ſmall inteſtines; others as biliary ducts; and others as lacteal veſſels.

[14] On this ſubject, as well as on ſeveral of the following chapters, the references contained in the notes to the 106th and 107th paragraphs, may be conſulted.

* For a further account of the alimentary canal, in the lower orders, ſee note (E) at the end of the chapter.

Additional Notes to the Seventh Chapter.

(A) In conſidering the proportionate lengths of the inteſtinal canal, and the relation which theſe bear to the kind of food, on which the animal ſubſiſts, many circumſtances muſt be taken into the account, beſides the mere meaſure of the inteſtine. Valvular projections of the internal membrane; dilatations of particular parts of the canal; and a large general diameter, compenſate for ſhortneſs of the inteſtine; and vice verſâ. The ſtructure of the ſtomach muſt alſo be conſidered; as, whether it is formed of more than one cavity; whether the œſophagus and inteſtine communicate with it in ſuch a manner, as to favour a ſpeedy tranſmiſſion of the food; or, whether there are cul de ſacs, which retain the aliment for a long time in the cavity. The formation of the jaws and teeth, and the more or leſs perfect trituration and comminution, which the food experiences in the mouth, muſt likewiſe be viewed in connection with the length and ſtructure of the alimentary canal.

The whole length of the canal is greater in the *mammalia* than in the other claſſes. It diminiſhes ſucceſſively, as we trace it in *birds*, *reptiles*, and *fiſhes*, being ſhorter than the body in ſome of the latter animals, which is never the caſe in the three firſt claſſes.

In omnivorous animals, the length of the canal holds a middle rank between thoſe which feed on fleſh, and ſuch as take vegetable food. Thus, in the rat, its proportion to the body is as 8 to 1; in the pig 13 to 1; in man 6 or 7 to 1. The diminution in length, in the latter caſe, is compenſated by other circumſtances, viz. the numerous valvulæ conniventes, and the preparation which the food undergoes, by the art of cookery.

In carnivorous animals, every circumſtance concurs, to accelerate the paſſage of the alimentary matter. It receives no maſtication; it is retained for a very ſhort time in the ſtomach; the inteſtine has no folds or valves; it is ſmall in diameter; and the whole canal, when compared to the body, is extremely ſhort, being 3 or 5 to 1.

The ruminating animals preſent the oppoſite ſtructure. The food undergoes a double maſtication, and paſſes through the various cavities of a complicated ſtomach. The inteſtines are very long; 27 times the length of the body in the *ram*. Hence the large inteſtines are not dilated, or cellular; nor is there a cæcum. The *ſolipeda* have not ſuch a length of canal, nor is their ſtomach complicated; but the large inteſtines are enormous, and dilated into ſacculi: and the cæcum is of a vaſt ſize; equal, indeed, to the ſtomach. The *rodentia*, which live on vegetables, have a very large cæcum, and a canal 12 or 16 times as long as the body. In the *rat*, which can take animal, as well as vegetable

food,

food, the canal is ſhorter than in the other rodentia.

There are ſome exceptions to the rule, which we have juſt mentioned, reſpecting the length of the canal in carnivorous and herbivorous animals. The *ſeal*, which takes animal food, has very long inteſtines: the *ſea-otter* reſembles it in this reſpect, and differs therein moſt remarkably from the common otter, which reſembles other carnivorous animals in the ſhortneſs of its inteſtinal tube. The length of canal in the former, is twelve times that of the animal; and only three times and a quarter in the latter. (HOME, in the *Philoſ. Tranſ.* 1799, part 2.) *Whales* have likewiſe a longer canal than other carnivorous mammalia; their ſtomach is complicated, and the inteſtine has longitudinal folds. It ſeems, therefore, that a conſiderable length of inteſtinal canal is found in all mammalia, which live much in the water, although they are carnivorous.

The *plantigrade* animals, which have carnivorous teeth, but feed equally well on vegetables, have a long canal: but it is very narrow, and poſſeſſes no cæcum, nor diſtinction of large inteſtine.

A ſpecies of bat (*veſpertilio noctula*), ſeems to have the ſhorteſt inteſtinal canal of any mammalia: it is only twice the length of the animal's body. On the contrary, the *rouſſette* (*veſp. vampyrus* LINN. *v. caninus* BLUM.) which lives entirely on vegetables, has it ſeven times as long.

A remarkable difference is obſerved, in the length of the canal between the wild and domeſticated breeds of the ſame ſpecies. In the *wild boar* the inteſtines are to the body as nine to one; in the tame animal, theſe proportions are as thirteen to one. In the *domeſtic cat*, five to one; in the *wild cat*, three to one. In the *bull* twenty-two to one; in the *buffalo*, twelve to one, They are, on the contrary, longer in the wild than in the tame rabbit; the proportions in the former being eleven; and in the latter nine to one.

The proportion of the inteſtinal canal to the length of the body in *birds*, is as two, three, four, or five to one. It is not always longeſt and largeſt in the graminivorous ſpecies; as many piſcivorous birds have it equally long.

It is hardly twice the length of [the body in many *reptiles;* and not ſo much in the *frog*, although it is nine times as long as the ſpace between the mouth and the anus in the *tadpole.*

The alimentary canal of ſome fiſhes, is continued ſtraight from the mouth to the anus, and does not therefore equal the length of the body. The *lamprey*, *ſkate*, and *ſhark* are thus circumſtanced.

(B) Moſt of the animals, which have a vertebral column, have the inteſtine divided into two parts; viz. the large and ſmall. The latter is commonly the longeſt, ſmalleſt in its diameter, and villous on its internal ſurface. The former is often thicker in its coats, and very rarely villous. In thoſe mammalia,

malia, which have this diſtinction, the ſeparation is marked by one or more appendages, which have the name of *cæcum* when large, of *vermiform appendix* when ſlender. *Man*, the *orang-outang*, and the *phaſcolome* (a ſpecies of rat having an abdominal pouch, from New Holland,) are the only animals, which have both cœcum and appendix. The *ornithorhynchus hyſtrix* has an appendix only: and moſt other mammalia have only a cæcum. All the *ſimiæ*, except the *orang-outang*, have a cæcum, like that of man, but want the appendix vermiformis.

Several poſſeſs neither cæcum nor appendix, as the *edentata*, (except the proper *ant-eaters*); the *tardigrada*, the *bats*, the *plantigrada*, except the *ichneumon*, the *muſtelæ*, and the *myoxi* (dormice); and the *cetacea*.

A *valvula coli* ſhews the diſtinction between the large and ſmall inteſtine, where the cœcum is wanting: as in the *ſloth* and *armadillo*. When this diſtinction does not exiſt, the large inteſtine is characteriſed by the want of villi, by a greater thickneſs of its coats, and particularly by a ſtrong layer of longitudinal muſcular fibres.

In animals, which have a cœcum, this part appears to be merely a prolongation of the large inteſtine below the termination of the ſmall. Yet in ſome caſes, the large inteſtine retains only for a ſhort ſpace, the ſame ſtructure, which the cœcum poſſeſſed, as in the flying lemur (*galeopithecus*), the *opoſſum*, moſt of the *rodentia* and *ruminantia*. In the herbivorous mammalia, the cæcum is generally large and cellular; and it is even ſo in omnivorous animals, as in *man*, in the genus *ſimia*, and *lemur*. In the *ruminantia*, where the ſtomach is very complicated, the cæcum is of a moderate ſize, and uniform. It is large and cellular in the *flying lemur*, and *opoſſum*, which are ſuppoſed to live much on animal ſubſtances.

The cæcum of the true carnivorous mammalia is conſtantly ſmall, and uniform in its cavity; and the reſt of the large inteſtine has the ſame characters. The large inteſtine of the herbivora is cellular; excepting the ruminantia, and ſome of the rodentia.

It may therefore be ſtated as a general rule, that the exiſtence of a large cæcum ſhews that the animal feeds on vegetables: and that carnivorous mammalia have either none, or a very ſmall one.

The *ornithorhynchus paradoxus* and *hyſtrix* have the end of the rectum forming a cloaca as in birds. The urinary bladder opens into this part. The penis of the male is contained within it; and the horns of the uterus open into it in the female. Home in the *Philoſ. Tranſ.* 1802, pt. 1. of the *o. paradoxus*, pt. 2. of the *o. hyſtrix*.

(C) The *burſa Fabricii* is an oval membranous bag; ſituated at the upper or back part of the cloaca, into which it opens by a ſlit-ſhaped aperture. Its ſize is proportionate to that of the animal; being one inch and a quarter long in the gooſe, and half an inch broad: and about a quarter of an inch in length in the ſparrow. According to the accurate obſervations of Mr. Macartney, its coats contain numerous glandular bodies, which furniſh a mucous ſecretion. (Article BIRDS in Rees's Cyclopædia).

(D) In the ſtructure and formation of the coats of the inteſtinal canal, there are not many differences in the *mammalia*. True *valvulæ conniventes* ſeem peculiar to *man* and the *monkeys*. But the internal ſurface of the inteſtine is always villous, and generally deſerves that appellation more than in the human ſubject. Some of the *carnivora*, as the *dog*, have very long villi: and this claſs has in general more muſcular inteſtines. A conſiderable number of mucous glands is found near their cæcum, when they have one. But the *ſeal* has theſe glands in greateſt number, and moſt diſtinct. They form, in that animal, a regular and unbroken ſeries through the whole length of the lower portion of the ſmall inteſtine; and are very viſible on account of their colour.

The villous coat of the inteſtine forms numerous oblong proceſſes in the *rhinoceros*. (Philoſ. Tranſ. 1801. pt. 1.)

The villi in the ſmall inteſtine of birds are remarkably long, numerous and elegant. They are moſt diſtinct, and clearly developed in the *graminivorous* birds. In the *oſtrich* they are rather flat thin laminæ than villi; but at the ſame time long and numerous, ſo as to preſent a very elegant ſtructure. The large inteſtine of birds is uniform on its ſurface; but the *oſtrich* preſents a very remarkable deviation, for its large inteſtines, which are very long, have numerous tranſverſe folds like the valvulæ conniventes of man.

The inteſtine of the *turtle* is covered with innumerable thin longitudinal proceſſes, lying cloſe together, and increaſing the ſurface of the gut to a vaſt extent. Theſe are moſt numerous in the upper part of the inteſtine, and gradually diminiſh in number below, until they ceaſe altogether. In this reſpect they reſemble the valvulæ conniventes of man; and the villi of all animals. For theſe ſtructures are always moſt diſtinct at the commencement of the canal, where abſorption of the chyle goes on to the greateſt extent. As the alimentary matter becomes deprived more and more of its nutritious parts, as it deſcends in the inteſtine, a leſs complicated apparatus for abſorption exiſts in the lower part of the canal, and is ſufficient for taking up the ſmall remains of really nutritious parts. This circumſtance is illuſtrated in the longitudinal folds of the cetaceous animals. At the commencement of the inteſtine, there are four or five of theſe: at different diſtances we meet with four, three, two, one, and laſtly the ſurface is completely uniform.

(E) As the part of his work, which the author has devoted to the alimentary canal of the lower orders of animals, is very ſhort, and as the ſubject is intereſting in many points of view, it ſeems right to ſubjoin a ſomewhat more ample account.

The ſimple globular *hydatid*, which is frequently found in the different viſcera, both of man and quadrupeds, has been ſuppoſed by ſome to be an animal conſiſting entirely of a ſtomach. Doubts, however, have lately been raiſed, whether or no this be really an animal. The reader, who wiſhes to ſee the arguments on both ſides of the queſtion, may conſult the "*Obſervations on the Manner in which Hydatids grow and multiply in the Human Body*," by J. HUNTER, M. D. in the 1ſt vol. of the *Tranſactions of a Society for the Improvement of Medical and Churürgical Knowledge*; and the note to the 82d paragraph of this work. Even if it were allowed that theſe bags are animals, it does not follow that their cavity is a ſtomach; and the attachment of the young to the ſides would rather juſtify us in conſidering it as the organ of generation.

The *hydatid*, which is more frequently found in animals,

animals; which poſſeſſes a head and mouth like the tænia, enabling it to attach itſelf to parts, and which can be ſeen to move when placed in warm-water, is generally allowed to poſſeſs an independent vitality. But whether the bag of water, which forms its body, be a ſtomach, is certainly doubtful.

The moſt ſimple form of an alimentary cavity exiſts in the common freſh-water polype *(hydra)*. It appears to be excavated in the ſubſtance of the body, and has a ſingle opening, ſituated in the centre of the ſpace ſurrounded by the tentacula. The nutritive matter ſoaks immediately into the body, and imparts its colour to the animal.

The large maſſes of gelatine, called *meduſæ*, which reſemble in form muſhrooms, and are found floating in the ſea; have a ſomewhat ſimilar ſtructure. A ſtomach is hollowed out in the pedicle; and veſſels, commencing from its cavity, convey the nutritious fluid over the body. Sometimes the ſtomach has a ſimple opening: in other caſes there are branching tentacula, on which canals commence by open orifices; theſe unite together to form larger tubes, and the ſucceſſive union of theſe veſſels forms at laſt four trunks, which open into the ſtomach, and convey the food into that cavity. This very ſingular ſtructure conſtitutes a remarkable analogy to the roots of trees; and CUVIER has formed a new genus under an appellation derived from this compariſon; viz. the *rhizoſtoma*, from ῥιζη a root, and ϛομα a mouth.

The ſtar-fiſh (*aſterias*) has a membranous cavity in the centre of its body, communicating externally by a ſingle opening. Two canals extend from this into each of the branches, or as they ſometimes called the fingers of the animal, where they ſubdivide, and form numerous blind proceſſes.

The tape-worm (*tænia*) has a ſmall canal running on each ſide of its body: the two tubes are joined together by tranſverſe productions at each joint.

The *aſcaris lumbricoides* (round-worm) has a ſimple canal running from one extremity of the body to the other.

The leech (*hirudo ſanguiſuga* or *medicinalis*) has a ſhort œſophagus and a very large ſtomach, divided by numerous membranous ſepta, which are perforated in the centre. It has been generally ſuppoſed that this animal has no anus; but CUVIER ſays, that it poſſeſſes a very ſmall one. (*Leçons d'Anat. Comp.* tom. 4. p. 141.): DUMERIL, on the contrary, denies its exiſtence. (*Zoologie Anatique*, p. 298.)

The common earth-worm (*lumbricus terreſtris*) has a long canal, divided by ſeveral partitions.

The aphrodite aculeata has an inteſtine running according to the length of the body, and ſending off on each ſide ſeveral blind proceſſes, which enlarge at their termination.

In the proper molluſca, beſides the ſtomach, which has been already noticed there, is an inteſtine, ſeldom of conſiderable length, making ſome turns in its courſe: it paſſes in all the acephalous molluſca through the heart.

The inteſtinal canal of inſects varies very much in the different genera and ſpecies. It may be ſtated on the whole, that a long and complicated inteſtinal tube, denotes that the inſect feeds on vegetables; while the contrary characters indicate animal food.

Great difference is found, in ſome inſtances, between the larva, and the perfect inſect. The voracious larvæ of beetles, *(ſcarabæi)*, and butterflies, have inteſtines ten times as large as the winged inſects, which are produced from them.

In the dragon-fly *(libellula)*, which is very carnivorous, the inteſtine is not longer than the body. There is a ſmall but muſcular ſtomach.

The *orthoptera*, (which claſs contains the locuſts, &c., well known for their deſtructive powers,) have a long and complicated alimentary apparatus. They have firſt a membranous ſtomach. This is ſucceeded by another cavity covered internally with ſcales or teeth, and poſſeſſing a very thick muſcular coat; in ſhort, a true gizzard.

Round the end of this the cæcal proceſſes are attached. There is, laſtly, an inteſtinal canal differing in length and diameter.

The aliamentary canal runs ſtraight along the body in the *cruſtacea,* and is uniform in its dimenſions, excepting the ſtomach.

CHAPTER VIII.

ON THE LIVER, SPLEEN, AND OMENTUM.

§ 121. WE may conveniently collect together, in this chapter, whatever is to be ſaid concerning the liver, ſpleen and omentum; ſince theſe parts are connected with each other in their functions.

The ſpleen and omentum ſeem to be leſs conſtantly found in the animal kingdom, than the liver, and to be in a manner ſubſervient to the latter viſcus: which, on the contrary, exiſts in every claſs and order of animals that is provided with a heart and circulating ſyſtem.

(A) MAMMALIA.

§ 122. Beſides the leſs important, and indeed conſtant variations in ſize, colour, diviſion into lobes[1], &c., the liver of theſe animals is diſtinguiſhed by two chief differences: firſt, in ſome genera and ſpecies it tranſmits all the bile immediately into the duodenum. Secondly, in ſeveral others a part of this fluid is previouſly collected in the gall bladder. Animals of the *horſe*[2] and *goat* kind, and the *cetacea* afford inſtances of the want of this receptacle.

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[1] It deſerves to be remarked here, as a peculiarity of the liver of ſome four-footed mammalia, which live in or about the ſea; namely, the *polar bear*, and ſome *ſeals*; that it ſeems to poſſeſs ſome poiſonous or noxious qualities when employed for food. HEEMSKERK's Companions experienced this in the former inſtance at *Nova Zemlia;* and Lord ANSON's ſquadron in the latter, on the coaſt of *Patagonia.*

On the contrary in ſome of thoſe which have it, there are *hepatico-cyſtic ducts*, which convey the bile immediately from the liver into this bladder: as in the *horned cattle.* (See note (A) at the end of the chapter).

In the *ox* and *ſheep*, the ſpleen is diſtinguiſhed by a peculiar cellular[3] ſtructure from the merely vaſcular texture which it poſſeſſes in other animals of this claſs.

Mammalia alone[4] poſſeſs a true and proper omentum. And the part, which has been called a ſpleen in other animals is very different in its ſtructure, connections, &c. from the ſame viſcus as it exiſts in this claſs.

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[2] Some have conſidered the large hepatic duct of the *horſe* as a gall-bladder. See Sir THOMAS BROWN's *Pſeudodoxia Epidemica,* p. 119. ed. of 1672. This might with more truth be ſaid of the *elephant,* where the hepatic duct has a conſiderable expanſion juſt at its entrance into the inteſtine. *Oeuvres de Pierre Camper,* tom. 2. ch. 4. § 3.

[3] STUKELY *on the Spleen,* tab. 3. and 4.

The hepatico-cyſtic ducts, and the cellular ſtructure of the ſpleen, are the more worthy of mention, as they have given riſe to errors in phyſiology.

[4] I quote only a ſingle inſtance of the peculiar appearances of the omentum in particular ſpecies; viz. that of the *racoon,* (*urſus*

(B) BIRDS.

§ 123. The liver is much larger in domeſticated, than in wild birds [5]. It is well-known that the gall-bladder is wanting in many ſpecies of this claſs, (for inſtance in the *pigeon*, *parrot*, *&c.)*: and ſometimes in particular individuals of a ſpecies, which commonly has it; as in the *common fowl*. (See note (B) at the end of the chapter).

A roundiſh lump of fat, which covers the inteſtines of ſome aquatic birds, has been conſidered as an omentum.

(C) AMPHIBIA.

§ 124. The liver, in theſe animals, is univerſally of conſiderable ſize; and in ſome inſtances, as

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(urſus lotor), which has a very remarkable ſtructure; and which I received from that zealous zootomiſt Dr. ALBERS, of *Bremen*. It is comparatively large, and conſiſts of innumerable ſtripes of fat, diſpoſed in a reticular form, and connected by an extremely delicate membrane, reſembling a ſpider's web.

[5] B. ROBINSON, *on the Food and Diſcharges of Human Bodies*, London, 1748-8. p. 97.

the *ſalamander*, of immenſe magnitude. I know no ſpecies in which the gall-bladder is wanting.

The yellow appendices, (*ductus adipoſi, appendices luteæ*) which are found in the *frog*, on either ſide of the ſpine, and ſometimes form one maſs, ſometimes are divided into ſeveral ſmaller portions, were conſidered by MALPIGHI as a kind of omentum[6]. That this reſemblance is very remote, appears from ſeveral circumſtances; and particularly from the conſtant and remarkable variations of ſize which occur in theſe parts at the pairing ſeaſon.

(D) FISHES.

§ 125. In many animals of this claſs, the ſhort inteſtinal canal is ſurrounded, and as it were conſolidated with a long liver. Some fiſhes, which are almoſt deſtitute of fat in the reſt of their body, have an abundance of oil in the liver; as, for inſtance, the *ſkate* and *cod*. It is wanting in ſome few ſpecies. (For an account of the ſituation of the ſpleen, ſee note (C) at the end of the chapter).

(E) INSECTS.

§ 126. An organ ſecreting bile, and which may therefore be regarded as a liver, is found in ſuch animals only of this claſs, as have a heart and ſyſtem of veſſels; viz. in the genus *cancer*[7]. We have already obſerved (§ 119.—note 12), that the blind appendices, found in ſeveral others, have been conſidered as biliary organs. See note (D).

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[6] *De Omento et Adipoſi Ductibus*, Oper. tom. 2. p. 35, &c.

The large adipoſe ſubſtance, which occupies the greateſt part of the body of larvæ, and of ſeveral inſects, has appeared to ſome zootomiſts to reſemble the omentum[8].

(F) VERMES.

§ 127. The organs, which ſecrete and contain the fluid of the *cuttle-fiſh*, have been regarded as of a biliary nature. Thus the *mytis* has been called the liver, and the *ink-bag* the gall-bladder[9].

Several *teſtacea*, particularly among the *bivalves*, have a liver ſurrounding their ſtomach, and pouring its bile into the cavity[10] of that organ. In many ſnails it occupies the upper turns of the ſhell [11] * †.

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[7] WILLIS *De Animâ Brutorum*, tab. 3. RÖSEL, vol. 3. tab. 58 and 59.

[8] LYONET, *Anatomie de la Chenille*, &c. tab. 5 and 12.

[9] Compare the repreſentations, which have been given by SWAMMERDAM, TURBERVILLE NEEDHAM, and MONRO.

[10] See POLI, vol. 1. where he repreſents this fact in ſeveral of the *teſtacea*.

Additional Notes to the Eighth Chapter.

(A) The liver of mammalia is in general divided into more numerous lobes; and the diviſions are carried deeper into its ſubſtance, than in the human ſubject. This is particularly the caſe in the *carnivora*, where the diviſions of the lobes extend through the whole maſs. But the utility, which MONRO has aſſigned to this ſtructure; viz. that of its allowing the parts to yield and glide on each other in the rapid motions of the animal, carries very little plauſibility with it. (*Eſſay on comparative Anatomy*, p. 11.)

In many animals of this claſs, as the *horſe*, the *ruminantia*, the *pachydermata*, and *whales*, the liver is not more divided than in man.

The *ductus choledochus* forms a pouch between

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[11] SWAMMERDAM, tab. 5. of the *helix pomatia*.

* For a further account of the liver of this claſs, ſee note (E).

† For ſome remarks on the panereas, ſee note (F).

the coats of the inteſtine, for receiving the pancreatic duct, in the *cat* and *elephant.*

All the *quadrumana*, *carnivora*, and *edentata* have a gall-bladder.

Many *rodentia*, particularly among the rats, want it. The *tardigrada*; the *elephant*, *rhinoceros*, and *pecari* among the pachydermata; the genus *cervus* and *camelus* among the ruminating animals; the *ſolipeda*; the *tricbecus* and *porpoiſe* alſo want this part. It does not exiſt in the *oſtrich* and *parrot;* but is found in all the *reptiles.* CUVIER thinks that it belongs particularly to carnivorous animals; that it is connected with their habit of long faſting; and ſerves as a reſervoir for the bile.

All the mammalia, which want it, except the *porpoiſe*, are vegetable eaters: and moſt reptiles, which univerſally poſſeſs it, live on animal food, *Léçons d'Anat. Comp.* tom. 4. p. 37.

The valvular tranſver ſefolds of the cyſtic duct belong only to the *ſimiæ*, beſides the human ſubject.

(B) The liver of birds is divided into two equal lobes. The hepatic duct opens ſeparately from the cyſtic; and its termination is generally, but not always preceded by one or more paucreatic ducts, and followed by that of the cyſtic duct.

The fundus of the gall-bladder receives branches from the hepatic duct, *(ductus hepaticyſtici)*; but that tube ſometimes unites with the cyſtic, as in the *duck*.

(C) The ſpleen gradually diminiſhes in ſize from the mammalia to fiſhes. In the *porpoiſe* there are ſeveral ſmall ſpleens; ſupplied from the arteries of the firſt ſtomach. It is always attached to the firſt, when there are ſeveral ſtomachs.

In birds it is always near the bulbus glanduloſus; but does not lie conſtantly very cloſe to the ſtomach in reptiles; as it is found in the meſentery of the *frog*. Neither is it very uniformly ſituated in fiſhes.

(D) The blind proceſſes, which are attached to the alimentary canal of inſects, are ſuppoſed by many to form a ſubſtitute for the liver. They generally contain a yellow bitter fluid. Their number and ſituation vary. They terminate for the moſt part near the ſtomach, but not conſtantly ſo. They are ſhort and numerous in the *dragon-fly*, and open near the anus. In the mole-cricket *(gryllus gryllotalpa)*, they form a bundle, and have a common opening in the middle of the inteſtine.

In the cruſtacea the liver is large, and conſiſts of blind tubes, opening into the commencement of the inteſtine. It forms the ſoft high flavoured ſubſtance of the crab and lobſter.

(E) A liver exiſts in all the molluſca, and is very large; but this claſs has no gall-bladder. The liver is ſupplied with blood from the aorta, and there is conſequently no *vena portarum.*

It is a completely miſtaken notion, that the black fluid of the *cuttle fiſh* is its bile. The *ink-bag* is indeed found between the two lobes of the liver in the *ſepia octopus:* and in front of them in the *calmar;* but in the common cuttle-fiſh (*ſepia officinalis*), it is at a conſiderable diſtance from this organ.

The real bile is poured, as uſual, into the alimentary canal.

In the gaſteropodous molluſca, as the *ſnail*, the liver is very large, and conſiſts of ſeveral lobes, having each an excretory duct. They ſurround the ſtomach and inteſtine, and open by ſeveral mouths into its cavity. The *aplyſia*, *onchidium*, *doris*, &c. have a ſimilar ſtructure.

In the acephalous diviſion of this claſs, it ſurrounds the ſtomach, and pours its ſecreted liquor into that cavity by many openings, the *oyſter* and *muſcle* exemplify this.

The proper worms (*vermes* of CUVIER); the *echinodermata* and *zoophytes* have nothing analogous to this gland.

(F) The author has entirely omitted ſpeaking on the pancreas in this part of his work; probably becauſe there are no remarks of any importance or intereſt to be made on the ſubject. The ſtructure of this gland in the mammalia, in birds, and in reptiles is the ſame, on the whole, as in the human ſubject: its form and ſize, its colour and conſiſtence, and its diviſion into lobules exhibit ſome ſlight and unimportant variations.

The termination of its duct or ducts, is diſtinct in birds from that of the *d. choledochus*. In the mammalia they generally open together, or there is a branch terminating in the *d. cheoldochus*, and another opening into the inteſtine, as in the *dog* and *elephant*, or they may be quite diſtinct, as in the *hare*, *porcupine*, and *marmot*. They may be ſeparate or diſtinct in different individuals of the ſame ſpecies, as in the *monkeys*.

The *ſkate* and *ſhark* have a pancreas ſimilar to to that of the three firſt claſſes of red-blooded animals. In other fiſhes the ſituation of this organ is occupied by the *cæcal appendices* or *pyloric cæca*; which afford a copious ſecretion, analogous, no doubt, to the pancreatic liquor. (Theſe are mentioned in § 118.) The internal ſurface of theſe tubes becomes very red on injection, and poſſeſſes a glandular and ſecreting appearance.

The appendices, which form ſeparate tubes in moſt fiſhes, are collected in the *ſturgeon* into one maſs, which is ſurrounded by muſcular fibres. In this body, which has a very manifeſt glandular ſtructure, the tubes join together, and open into the inteſtines by three large orifices.

CHAPTER IX.

ON THE URINARY ORGANS.

§ 128. THESE emunctory organs do not exiſt in ſeveral animals, which have a biliary apparatus. They are confined to the red-blooded claſſes; all of which have kidneys, while ſome orders and genera have not an urinary bladder.

(A) MAMMALIA.

§ 129. In ſome animals of this claſs, as the *bears* [1], the kidney reſembles a bunch of grapes, being compoſed of ſeveral [2] ſmall and diſtinct portions, which are connected by means of their blood-veſſels and ureters, with the common trunks of thoſe veſſels. The urinary bladder is more looſe [3] in the abdomen of moſt quadrupeds, than in the human ſubject. It is comparatively much ſmaller in carnivorous than in herbivorous animals; and is particularly large in the ruminating biſulca and the *hare*[4]. (See note (A) at the end of the chapter.)

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[1] EUSTACHII, *Tab. Anat.* tab. 4.

[2] In the *bear* there are fifty or more, ſee H. F. FLEMING; *German Huntſman*, Leipzig, 1719, p. 120.

[3] VESALII *Anatomicarum Fallopii Obſervationum Examen.* p. 126. RIOLANI *Anthropographia*, p. 241.

(B) BIRDS.

§ 130. The kidneys[5] of this claſs (with a few exceptions, as the *cormorant*, &c.) form a double row of diſtinct but connected glandular bodies[6], placed on both ſides of the lumbar vertebræ, in cavities of the oſſa innominata. The urinary bladder is wanting in the whole claſs; and the ureters open into the cloaca.

(C.) AMPHIBIA.

§ 131. Animals of the genus *teſtudo* and *rana* have an urinary bladder; which is double in many of the frogs properly ſo called. The *crocodile* on the contrary, and ſeveral true *lizards* have none. The ſame remark applies to the ſerpents, in whom the ureters open into the cloaca. See note (B).

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[4] Urinary ſtones, often of very conſiderable ſize, are found not unfrequently in horſes, whoſe inteſtinal concretions have been already noticed. Their compoſition differs conſiderably, according to the inveſtigations of FOURCROY and VAUQUELIN from the urinary ſtones of man; ſince they contain neither phoſphoric, nor lithic, but carbonic acid.

[5] ALOYS. GALVANI in the *Comment. Inſtit. Bononiens*, tom. 5. pl. 9. p. 508.

[6] One of the moſt inſtructive examples of the remarkable analogy between the ſtructure of the ſcereting viſcera, properly ſo called, and the conglomerate glands. See the *Inſtitutiones Phyſiologiæ*, § 470 and 471.

(D) FISHES.

§ 132. The glandulæ ſuprarenales are wanting in this claſs; and they ſeem therefore to be confined to ſuch animals as breath with lungs. Although we cannot perceive of what uſe an urinary bladder can be to fiſhes, and animals which live in water, ſeveral genera and ſpecies have one.

Additional Notes to the Ninth Chapter.

(A) The ſtructure of the kidney in mammalia diſplays two very oppoſite varieties; which may be called the *ſimple* and the *conglomerated* kidneys. In the former there is a ſingle papilla, which is ſurrounded by an exterior cruſt of the cortical ſubſtance. This is the caſe in all the *feræ*; and in ſome other animals, as many *rodentia*. The other kind of kidney conſiſts of an aggregation of ſmall kidneys, connected by cellular ſubſtance. It appears that this form of the gland is found in all thoſe mammalia, which either live in, or frequent the water. I have obſerved it in the *ſeal* and *porpoiſe*, where the ſmall kidneys are extremely numerous, and ſend branches to the ureter without forming a pelvis. Mr. HUNTER ſtates that it belongs to all the whales. (*Philoſ. Tranſ.* 1807. pt. 2). The *otter* has the ſame ſtructure; but its ſmall kidneys are not ſo numerous as in the animals above-mentioned. (HOME, of the *ſea-otter.* (*Lutra marina*). *Philoſ. Tranſ.* 1796. pt. 2.) It is remarkable that the brown bear (*urſus arctos*) which lives on land, ſhould have this ſtructure as well as the white polar bear (*urſus maritimus*), which inhabiting the coaſts, and floating ice of the northern regions, ſpends much of its time in the water. Mr. HUNTER (loco citato) concludes, that it is becauſe Nature wiſhes to preſerve an uniformity in the ſtructure of ſimilar animals. But the badger, (*urſus meles*), which is a very ſimilar animal, has the uni-lobular kidney. The number of ſmall kidneys in the bear is 50 or 60: and it appears that each conſiſts of two papillæ. (See the account of the diſſection of a bear, by the French Academicians: which is alſo given in BLASIUS's Collection. *Anatom. Animal.* tab. 32. fig. 2, 3, 4.)

(B) The two large bags, which the author, and alſo CUVIER, (*Léçons d'Anat. Comp.* tom. 5. p. 237.) repreſent as urinary bladders of the *frog and toad*, are ſtated by TOWNSON to have no connection with the ureter. Indeed it is very clear that the ureters open at the poſterior part of the rectum, while theſe two receptacles terminate on the front of that inteſtine. (See his *Tracts and Obſervations*, p. 66. tab. 3.) He ſtates that the fluid contained in theſe reſervoirs is a pure water. The ſize of theſe bags, which exceeds all ordinary proportion to the bulk of the kidney, renders it likewiſe probable that they are not receptacles of urine. Either of the bags is at leaſt twenty or thirty times as large as the kidney.

CHAPTER X.

ON THE EXTERNAL INTEGUMENTS.

§ 133 AMONG the various objects and functions of the common integuments, as they are called, one of the moſt important, and moſt general, in red blooded animals, is the office which they perform as emunctory organs. Hence we may introduce here with propriety what we have to ſay on the ſubject.

§ 134. The baſis of all the other coverings conſiſts in the proper ſkin *(cutis vera)*, which is common to the four claſſes of red-blooded animals, and may be regarded as the condenſed external ſurface of the cellular ſubſtance, with nerves, blood-veſſels, and abſorbents interwoven in its texture. This is covered externally by the cuticle, which is very uniform in its ſtructure, at leaſt in ſuch animals as breathe by means of lungs. (See note (A) at the end of the chapter.) The rete mucoſum lies between theſe; but it can only be ſhewn, as a diſtinct layer of the ſkin in warm-blooded animals. (See note (B.) Laſtly, the cuticle is furniſhed in the different claſſes with peculiar organs for the formation and excretion of particular matters; viz. *hairs* in mammalia, *feathers* in birds.

(A) MAMMALIA.

§ 135. The cutis of this claſs varies infinitely in thickneſs. It is extremely thin and delicate in the wing of the *bat*, and on the contrary, monſtrouſly thick in the *rhinoceros*, *elephant*, &c. alſo in the web-footed animals, particularly the *walrus*.[1] The form of the papillæ on its external ſurface is very various in the different animals of this claſs, as, indeed, in different parts of the ſame animal. They are ſometimes threadlike, as on the paws of the *bear*, and are very elegant on the teats of the true whale[2] *(balæna myſticetus)*. See note (C.)

The colour of the rete mucoſum varies, even in individuals of the ſame ſpecies, as in the different races of mankind. It is thickeſt in ſome cetacea.[3]

In ſome ſpotted domeſtic animals, particularly the *ſheep*, *rabbit*, and *dog*, there is a remarkable connexion between the colour of the palate, and even, ſometimes of the iris, and that of the ſkin; for ſpots of ſimilar deſcriptions are found in both parts.[4]

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[1] Hence the old Normans uſed to make their almoſt imperiſhable cables from the ſkin of this animal. See J. SPELMAN, *vita Ælfridi magni Anglorum Regis*. p. 205.

[2] I have obſerved this in ſeveral macacos *(ſimia cynomolgus)* and mandrills *(Papio Maimon.)*.

[3] I have had an opportunity of examining the ſkin of the cetacea in a *Balæna boops*, and in a dolphin, *(delphinus delphis)* In both the rete mucoſum was very thick; but by no means equal to the breadth of a finger, as is repreſented in the *Muſeum Gaubianum*. 1783, 8, p. 14.

The cuticle is often of very unequal thickneſs in particular parts, from the different purpoſes to which it is deſtined. Thus, it is very thin on the points of the fingers in *apes* and *baboons*, when compared with its great thickneſs where it covers the callofities on which they ſit. In ſome thick ſkinned animals, particularly the elephant, it forms a kind of horny proceſſes,[5] lying cloſe together in ſeveral parts of the body. But differences of this kind are too numerous to admit of their being all noticed in this work.

§ 136. Hairs, at leaſt ſingle ones, are found in all adult mammalia, even without excepting the cetacea. In various ſtates of thickneſs and ſtrength, they conſtitute every intermediate ſubſtance, from the fineſt wool to the ſtrongeſt quills of the porcupine. Thick briſtles, and hairs, as they are found, for inſtance, in the tail of the elephant, and other animals, reſemble horn, or fiſh bones in texture; while on the other hand, both theſe ſubſtances may be eaſily ſplit into a kind of briſtles. Hairs are commonly cylindrical; ſome, however, are broad with two ſharp edges; as in the toes of the *ornithorhynchus*, and the common *porcupine*. Others, as the whiſkers of the *ſeal*,[6] are also flat, but have rounded and denticulated margins, ſo that they have a kind of knotty, or jointed appearance. Something ſimilar may be obſerved in the hair of ſome cloven hoofed[7] animals, and moſt remarkably in that which covers the ſcent-bag of the muſk Goat. *(moſchus moſchiferus)*. Theſe are at the ſame time filled with a very looſe medullary texture, and conſequently very brittle. Some are thick and firm, but perforated by a narrow tube, which runs through their axis, as the long ſtiff whiſkers of the

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[4] See among other works Schneider's additions to his German tranſlation of Monro's *Phyſiology of Fiſhes*.

[5] Theſe proceſſes, as I obſerved them on the proboſcis of the elephant, appeared very ſimilar to the warty cuticle of the two Engliſh *porcupine men*, whom I lately ſaw, and have deſcribed in Voigt's *new Magazine*, vol 3, pt. 4. See alſo W. G. Tilesius's *Deſcription and Delineation of the two Porcupine men*, in German, Altenburg, 1802, folio.

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[6] ALBINI *Annotat. Academ.* lib. 3. p. 66.

[7] In conſequence of a degeneration of the formative impulſe, which ſeems to reſide chiefly in an unnatural formation of the ſkin, the hair of the human ſubject may aſſume an unuſual appearance, ſimilar to that of ſome quadrupeds, particularly of the *goat* and *deer* kind. This was the caſe with a woman from Triers, who was ſhewn here, as well as in many parts of Europe, in her ſeventeenth year. See LAVATER's *Phyſiognomical Fragments*, in German, part 4, p. 68. And the ſupplement to BUFFON, vol. 4, p. 571.

phoca urſina. The hairs on the tail of ſome ſpecies of porcupine are entirely hollow, like the quill of a feather.

The hair is the moſt incorruptible part of the body, and poſſeſſes in great perfection, both kinds of reproductive power; viz. the *natural**, which takes place in a healthy ſtate, and the *extraordinary*, which is exerted after an accidental loſs.[8] It is electrical in ſome ſpecies, and ſerves in thoſe animals which poſſeſs much of it, as a mode of excreting ſuperfluous phoſphoric acid.[9]

There are ſecretions from the integuments in ſome ſpecies of mammalia, manifeſting themſelves by peculiar ſmells, which conſtitute ſpecific characters in ſome of the horſe and dog-kind, as completely as the national ſmell of certain varieties of the human race.[10]

(B) Birds.

§ 137. The integuments of birds have the ſame three parts with thoſe of mammalia. Some are furniſhed with hair in particular ſituations; as the *vultur barbatus*, the *raven*, and the *turkey*. Others, as the *caſſowary*, have long ſpines like fiſh bones in their wings, which approach in the tubular ſtructure of their roots, to the formation of feathers; the univerſal and peculiar covering of this claſs of animals. The particular differences in the formation of the feathers are innumerable. Among the moſt remarkable, are the ſmall ſcale-like feathers of the *penguin's* wing; and the horny, flat, and pointed proceſſes on the tip of the neck, and wing-feathers of the *common fowl* in its wild ſtate; and on thoſe of the Bohemian chatterer, *(ampelis garrulus.)* Several birds in different orders, have two or more feathers ariſing from a common quill.[11]

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* For an explanation of theſe terms, ſee note G at the end of the chapter.

[8] *Manual of Natural Hiſtory*, in German, p. 28 of the 6th edition.

[9] Fourcroy *Syſteme des Connoiſſances Chirurgiques.* v. 9. p. 270.

[10] I have ſaid more on this ſubject in the third edition of my work *De Generis Humani varietate Nativa.* p. 163.

The periodical renewing of the feathery covering, at what is called the moulting ſeaſon, takes place in a ſhort ſpace of time, and comes therefore more under our obſervation, than the change of the hair in mammalia. This proceſs has afforded a very intereſting phyſiological remark, which has been often made in ſeveral ſpecies of thoſe birds, in which the male and female have different plumage;

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[11] In a young *oſtrich*, which had juſt quitted the egg, and which now lies before me, there are as many as twenty feathers on the back, proceeding from a ſingle barrel.

viz. that as the latter ceaſes in her old age to lay eggs, ſhe obtains the male plumage.

Laſtly, the integuments of birds ſerve the office of emunctory organs, which is proved even by the proceſs of moulting, as well as by the ſeparation of peculiar matters from the ſkin. Thus the cockatoo (*Pſittacus criſtatus*), as well as ſome other ſpecies of *Pſittaci*, and ſeveral birds of different orders, have a large quantity of white mealy duſt diſcharged from their ſkin, particularly at the pairing time.

(C) Amphibia.

§ 138. The very various integuments, which are found in the different orders and genera of this claſs, conſiſting of ſhields, rings, ſcales or ſimple ſkin, are covered externally with cuticle, which is frequently ſeparated in many of theſe animals, as in the ſnake, (forming what is called in German, *Natterhemd*, i. e. ſnakes-ſhirt) and *water-newt*.

This proceſs of ſeparation is repeated every week for ſome time in the latter animal, particularly in ſpring and autumn. Some which have ſmall fine ſcales, as the *chameleon*, or a ſimple ſkin, as ſome *frogs* change their colour occaſionally, either from difference in the light or warmth, or from the effect of their paſſions. (For a peculiarity in the ſkin of the toad, ſee note (D).

(D) Fishes.

§ 139. All fiſhes, without exception, are covered with ſcales, which are bare in thoſe which inhabit the open ſea, but on the contrary are covered with a mucous membrane in thoſe which live on coaſts, or in freſh water. It is remarkable, that the colour of the ſkin in ſome fiſhes, as for inſtance, the *mullet*, (*mullus barbatus*) depends on that of the liver.[12] The ſcales are not changed like hair and feathers, but are perennial; and are ſaid to receive yearly, an additional layer to their laminated texture, from the number of which the age of the animal may conſequently be determined. (For ſome account of the epidermis in the lower orders ſee note E. and of the various inſenſible coverings note (F).

Additional Notes to the Tenth Chapter.

(A) The epidermis of the cetacea is quite ſmooth; and marked with none of thoſe lines, which are ſo often ſeen in the other mammalia.

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[12] Santorini *Obs. Anatom.* Venet. 1724, 4. p. 4.

It is detached from the ſurface, in the form of ſmall ſcales, in all the mammalia, except the whales. And in ſome this happens chiefly at the ſeaſon when their hair is ſhed. It gives the ſkin a brauny appearance.

(B) It is in the rete mucosum that the colour of the ſkin reſides; but this part poſſeſſes in very few inſtances, any brilliancy of colour in the mammalia. It is of a beautiful red and violet on the noſe and buttocks of ſome *baboons:* and ſilvery white on the abdomen of the *cetacea.* It is remarkably thick on theſe animals; being about the ſixteenth of an inch on the back, and ſuch parts as are of a black colour.

(C) Villi, or papillæ of the ſkin are found on thoſe parts which correſpond to the toes and fingers of man. They exiſt alſo on the trunk of the elephant, and on the ſnout of the mole and pig.

The cutis of mammalia is much thicker on the back than on the belly.

(D) The ſkin of the frog and toad does not adhere to the ſubjacent parts, as in other animals; but is attached to them only at a few points, and is unconnected elſewhere: ſo that it may be compared to a bag containing the animal.

(E) The lower orders poſſeſs in general an epidermis. In the *teſtacea* it uſually covers the ſurface

face of the ſhell, and obſcures the brilliancy of that part, until it is removed. It maybe ſeen by plunging a ſnail-ſhell into boiling water. It is very thick and villous in ſome ſpecies, as in the *arca piloſa.*

Cruſtacea have it; alſo inſects both in their perfect and larva ſtates. It is ſhed in the latter ſeveral times before the change to the ſtate of chryſalis: (ſeven times in moſt of the *butterflies* and *bombyces).*

It is very diſtinct in the vermes; as in the common *earthworm* and *leech*, which often ſhed it. In the *ſipunculus ſaccatus* it is looſe and not adherent to the ſurface.

(F) Hairs are formed in ſmall bulbous bodies implanted in the true ſkin, and grow from their baſe.

If one of the large hairs, which grow on particular parts of ſome animals be examined with glaſſes, its ſurface appears grooved, as if it were compoſed of ſeveral filaments; and one or two canals are diſcovered in the ſubſtance of the hair, containing a kind of fluid, which has been called the medulla.

In the *hedgehog*, *porcupine*, &c. theſe filaments are covered with a layer of horny ſubſtance; and the cavity is filled with a white ſpongy matter.

The colour of the hair is influenced in great meaſure by that of the rete mucoſum: and this circumſtance is particularly obſervable in the human ſubject. Its texture is much modified by climate and mode of life. The *dog* in Siberia, and the *ſheep* in Iceland are covered with a kind of long and ſtiff hairs, while the ſame animals, in very hot countries, as in Guinea, loſe this covering altogether. A ſpecies of *goat* furniſhes the long and ſilky hair, which is manufactured into the valuable ſhawls of Caſhmere. The *cat*, *rabbit*, and *goat* are covered with a very long and peculiar kind of hair in Angora, a ſmall diſtrict of Aſia Minor; and the ſuperior qualities of the Spaniſh wool are well known.

This ſeems to be the proper place for conſidering, in a curſory manner, the other inſenſible parts, which are found on the ſurface of the body.

The *horns* of the mammalia are generally formed on proceſſes of the frontal bone; which they cover in the manner of a ſheath, as a glove does the finger. They conſiſt of a ſolid, inſenſible, and elaſtic ſubſtance; which in many caſes has a fibrous appearance, as if it were compoſed of an aggregation of hairs. This ſtructure is moſt particularly remarkable in the rhinoceros; where the horn is ſolid, and ſituated over the naſal bone. The fibres analogous to hairs are very diſtinct, and are obſervable at the baſe of the horn, detached from its ſubſtance in the form of briſtles. The maſs of the horn is entirely pervaded by innumerable pores.

In thoſe animals which have a long proceſs within the horn, the os frontis begins to form a tubercle, about the ſeventh month of conception. This being

ing gradually elongated, elevates the integuments, which become callous, and harden, as the horn is lengthened. Between the bone and the latter part a ſoft vaſcular ſubſtance is interpoſed: from which the horn is produced, by means of ſucceſſive additions to its baſe and internal ſurface.

The *nails* and *claws* of animals are formed juſt like horns; they cover a proceſs of the laſt phalanx, which is analogous to the frontal proceſs of the horn; and grow from the root or baſe, to which the integuments are attached, while they wear away at the looſe edge.

The *hoof* of the *horſe*, *aſs*, &c. is a horny covering of the laſt phalanx; ſimilar, in its ſtructure and formation, to the parts juſt mentioned, but including the whole of the bone. Its internal ſurface in the horſe is formed into a vaſt number of thin plates, which are placed alternately with correſponding laminæ of the vaſcular ſubſtance, and conſtitute a moſt cloſe connection between the two parts. This union is ſo firm, that, when the inferior portion of the hoof has been removed, a horſe may be trotted roughly without the foot being ſeparated from the upper part of the hoof.

The body of a bird which has juſt quitted the egg, is covered with hair inſtead of feathers. Faſciculi of hairs are produced from one common bulb, which is the rudiment of the future feather. In a few days a black cylinder appears, which opens at its extremity, and gives paſſage to the feather.

The oppoſite end receives thoſe blood-veſſels, which ſupply the vaſcular ſubſtance in the barrel of the feather; when the ſtalk of the feather has received its complete growth, this vaſcular body is dried up, and preſents the well-known appearance in the barrel of quills.

The parts which have been juſt deſcribed, as well as the epidermis, and the ſcales, or other hard coverings of reptiles and fiſhes poſſeſs neither veſſels nor nerves; and therefore the whole ſuperficies of an animal's body is really inſenſible, and conſtitutes a dead medium, through which impreſſions are conveyed to the ſubjacent living parts.

(G) I introduce the following quotation from the 2d chapter of the author's *Manual of Natural Hiſtory* (*Handbuch der Naturgeſchichte*, ed. 6, Göttingen, 1799) becauſe it explains the terms made uſe of in the 136th paragraph; repreſents the ſubject in an intereſting point of view, and contains the reſult of ſome curious experiments.

"In ſpeaking of the growth of organized bodies, we muſt notice their power of reproduction,—that wonderful property, of reſtoring or renewing parts, that have been mutilated or entirely loſt. This is one of the wiſeſt proviſions of nature for guarding animals and plants againſt the numerous dangers, by which they are ſurrounded. Hence, when viewed in connection with the ſyſtem of growth altogether, it conſtitutes one of thoſe grand characters, which diſtinguiſh the machines that proceed from the hand of the Creator, from all the productions of human ſkill. The ſprings and wheels of mechanical inſtruments have no power of repairing themſelves when injured or worn; but ſuch a power, in different degrees is imparted to every animal and plant.

At different periods of the year, ſeveral organized beings loſe by a ſpontaneous and natural proceſs certain parts of their body, which are ſubſequently renewed. Examples of this occur in the fall of the Stag's horns; in the moulting of birds; in the renewal of the cuticle of ſerpents, and of the larvæ of inſects, and that of the ſhell of the cruſtacea; the fall of the leaves of trees, &c. This may be called *ordinary* or *natural* reproduction.

The ſecond, or *extraordinary* kind of reproductive power is that, by which wounds, fractures, or any accidental mutilation or loſs of parts of an organized body, are remedied or reſtored. Man indeed, and ſuch animals as are nearly allied to him, poſſeſs this property in a very limited degree, while its ſtrength and perfection are truly aſtoniſhing in ſeveral cold-blooded animals, as the water-newt, the crab and lobſter, ſnails, earth-worms, (lumbricus terreſtris,) ſea-anemones, *(actinia)*, the ſtarfiſh, *(aſterias,)* freſh-water polipes *(hydra)*, &c.

Some experiments on this reproductive power require a hand exerciſed in ſuch employments, together with various precautions, and a favourable combination of circumſtances, for their ſucceſs. Hence perſons muſt be cautious in concluding againſt the truth of any ſtatement, becauſe their own experiments do not ſucceed. After ſeveral fruitleſs attempts on this ſubject, I have lately succeeded in obſerving the reproduction of the whole head of the ſnail *(helix pomatia)* with its four horns; which occupied about ſix months.

I preſerve in ſpirits a large water-newt *(lacerta paluſtris)*, from which I extirpated nearly the whole eye ſeveral years ago. All the humours were diſcharged, and then four-fifths of the emptied coats were cut away. In the courſe of ten months an entirely new eye-ball was formed; with cornea, iris, cryſtalline lens, &c.; and this is only diſtinguiſhed from the ſame organ on the oppoſite ſide, by being ſmaller." (See the *Gottingen Literary Notices* for 1787) p. 28, 30.

CHAPTER XI.

ON SEVERAL PECULIAR SECRETIONS.

§ 140. IT is neceſſary that we ſhould take notice of ſome organs, deſtined for the ſecretion of peculiar fluids, the uſe of which is not hitherto ſufficiently determined. Theſe occur in particular claſſes, or in certain genera and ſpecies of animals; and may be moſt conveniently conſidered here, at the end of that diviſion, which treats of the natural functions.

(A) MAMMALIA.

§ 141. Beſides the well-known ſalivary glands, there is another, which has been deſcribed by NUCK in the orbit, particularly of the *dog*, and ſome other predacious animals, which has an excretory duct opening near the laſt tooth of the upper jaw[1].

§ 142. Both ſexes of both ſpecies of the *elephant*, viz. the *African* and *Indian*, have a conſiderable gland[2] at the temple, between the eye and meatus auditorius, ſecreting in the rutting ſeaſon a browniſh juice, which is diſcharged through an opening in the ſkin[3].

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[1] NUCK *Sialographia*, tab. 3 and 6.

As far as regards the ſtructure of the organ, this ſecretion reſembles moſt, that of the gland placed at the back of the Mexican muſk hog or pecare (*ſus tajaçu)*. (See note (A), at the end of the chapter).

§ 143. Several ruminating *biſulca*, and the *hare*, have, in the part which has been noticed above (§ 16.), *ſebaceous ſinuſes*, which have received that name from the adipous and viſcous ſubſtance, which is ſeparated there in great abundance in ſome animals, and which is well known in the *ſtag*, where it is ſuppoſed to be of a lacrymal nature[4].

§ 144. In moſt of the *ruminating animals*, and in the *hare*, there are cavities in the groins, near the genitals, called by Pallas *antra inguinatia ;* and containing a ſtrong-ſcented ſebaceous ſubſtance ſecreted from glands which lie under the integuments [5].

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[2] See the *Hiſtoire des Animaux* of the Pariſian academicians, part 3. p. 138, and CAMPER's plates on the anatomy of the elephant, which were prepared in his 70th year.

[3] This circumſtance has been remarked of old, and has been noticed in the Indian Mythology. See WILFORD in the *Aſiatic Reſearches* vol. 3. p. 443.; it occurs likewiſe in STRABO. Compare alſo BEAULIEU *Voyage aux Indes Orientales*, p. 105. (in the collection of THEVENOT the elder, vol. 2.) and J. W. HEYDT's "*Eaſt Indian Theatre*," in German, p. 212.

[4] See profeſſor SCHNEIDER in the *Leipſig Magazine for Natural Hiſtory*, in German, 1787, p. 436.

§ 145. Some other mammalia have pouches on the abdomen, covered internally with a fine hair, and containing fatty ſecretions of peculiar odours. Of this kind are the bags near the anus of the *badger ;* and that which contains the teats of the female marſupial animals [6].

§ 146. There are alſo in the *badger*, and the *opoſſums*, as well as in ſeveral other carnivorous animals, (both among thoſe, which are furniſhed with ſeparate toes (*digitata*), and thoſe which are webfooted (*palmata*) peculiar glands and bags at the end of the rectum, ſecreting a yellow ſubſtance of a ſtrong and diſagreeable ſmell in its recent ſtate, and which frequently gives to their excrement a kind of muſk-like odour [7]. (See note (B).

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[5] Ibid, p. 430.

[6] The yellow matter contained in this pouch, was compared by TYSON with that which is ſecreted in the axilla of the human ſubject. *Phil. Tranſ.* vol. 20. p. 120.

[7] See GREW *Muſeum Regalis Societ.* tab. 23. where he repreſents theſe bags in the *polecat, weaſel, fox*, and *cat*. DAUBENTON tom. 9, tab. 4. in the *lion*, tab. 16. in the *panther*, tab. 33. in the *civette*, tom. 7. tab. 13. in the *otter*.

§ 147. Theſe anal glands muſt be diſtinguiſhed from another kind of ſimilar glands and bags, which alſo ſecrete ſtrong-ſcented matters, but ſeem to be rather connected with the genitals[8]. Theſe are found in ſome of the ſame carnivorous animals, which poſſeſs the anal glands, as the *lion*, the *civette*, &c.; alſo in many herbivora, which want the latter organs; in ſome of whom they exiſt in both ſexes, as in the *beaver*[9], the *ondatra*[10] (*mus zibethicus*), &c. in others they are peculiar to the male, as in the muſk animal[11], whoſe pouch is found in the prepuce near the navel. (See note (C).

§ 148. We muſt alſo mention here the glandular cavities, covered internally with hair, which are found in the feet of ſeveral ruminating biſulca, and particularly in the ſheep. They have an excretory duct opening at the junction of the toes[12];

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[8] Tyson, who firſt carefully examined the different kinds of what he calls "*ſcent bags*," has not diſtinguiſhed them from each other. See Plot's *Natural Hiſtory of Oxfordſhire*, p. 305. and the *Philoſ. Tranſ.* vol. 13 and 20. alſo Haller *Elem. Phyſiol.* tom. 7. p. 147, &c.

[9] Daubenton, tom. 8. tab. 41. 42.

[10] Sarrazin in the *Mem. de l'Acad. des Sci.* 1725. tab. 12. 13.

[11] Pallas *Spicileg. Zoolog.* 13. tab. 6.

[12] R. Livingstone in the 2d vol. of the *Tranſ. of the Society of New York*, p. 140.

and the obſtruction of this, particularly from a long continuation of wet weather, occaſions troubleſome ſymptoms.

(B) Birds.

§ 149. Although birds do not maſticate their food, ſeveral of them, particularly among the *pici*, have conſiderable *ſalivary glands* at the ſides of the lower mandible. The ſecretion of theſe glands ſerves to facilitate the numerous and ſtrong motions performed by the tongue in deglutition. (See note (D).

The *pancreas* is of conſiderable ſize particularly in thoſe birds of prey, which do not drink: its form and ſtructure vary conſiderably.

§ 150. The glands which ſecrete the oil, on the upper part of the tail, are largeſt in aquatic birds; in ſome of which, as the *anas moſchata*, the ſecreted ſubſtance has a muſk-like odour. In that race of the common fowl, which has no tail, (the *Gallus ecaudatus)* this organ no longer exiſts.[13] (See note (E).

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[13] Reaumeur, *Art de fâire éclorre les Oiſeaux Domeſtiques.* tom. II. p. 332.

(C) AMPHIBIA.

§ 151. I do not think it probable, that the part, which has often been conſidered as a *pancreas* in this and the following claſſes of animals, really deſerves that name [14].

Anal glands, which diſſeminate a ſtrong ſpecific odour at certain times are found in ſome animals of this claſs; for inſtance in the Cayman *(Lacerta Alligator)*, and the rattleſnake [15].

§ 152. An acrid fluid exudes through numerous pores of the ſkin in ſome reptiles, when they are irritated; as in the *ſalamander* and in *toads*. It is ſaid that the *gecko* ſecretes a really venomous fluid between its toes. But there is a much more dangerous kind of poiſon formed in ſome ſerpents, which are diſtinguiſhed from the innocent ones by the organs pointed out in the 71ſt paragraph. (See note (F).

(D) FISHES.

§ 153. The moſt univerſal ſecretion in this claſs, which comes under the preſent chapter, is that of the mucus, which beſmears their ſkin and ſcales, and which is formed in canals[16] lying near the *lateral lines*, and in the ſame direction with them; one or more of theſe canals running on each ſide from the head to the tail-fin. In ſome fiſhes the mucus is poured out in the intervals of the ſcales; but in others thoſe parts are perforated by regular openings for its diſcharge[17]. (See note (G).

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[14] Zootomiſts have not been able to agree on this point. CHARAS took that to be the pancreas of ſerpents, which TYSON with the ancients called the ſpleen.

[15] TYSON in the Philoſ. Tranſ. vol. 13. p. 58.

(E) Insects.

There are no true conglomerate glands, nor analogous parts in inſects; but their diffierent ſecretions are performed by looſe veſſels[18]. Beſides the different ſecretions of peculiar matters, which belong excluſively to ſingle ſpecies, as the vapour, which ſome carabi (*carabus crepitans*, *marginatus*, &c.) diſcharge, and the ſtrong odours with which ſeveral of the bug-kind defend themſelves in caſe of neceſſity, two kinds of ſecreted fluids deſerve to be particularly remarked in this claſs: the ſilk which is formed by the larvæ of phalenæ[19] (moths) and by ſpiders[20]; ſee note (H) and the *poiſon* with which ſeveral hymenopterous[1] and apterous[2] inſects are armed. See note (I).

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[16] See the two claſſical works of Steno, who diſcovered theſe parts: *de muſculis et glandulis*, p. 42. and *elementor. myolog. ſpecimen*. p. 72.; alſo Lorenzini, p. 7. and 21.

[17] A. Q. Rivinus in the Leipſic *Acta Eruditorum*, 1687. p. 161. and Perrault *Eſſais de Phyſique*, tom. 3. tab. 20.

[18] Cuvier in the *Memoires de la Societé d'Hiſt. Nat. de Paris*. an. 7. p. 40.

The wax, which is prepared by the honey-bees, and by the Indian *coccus mellificus*, deſerves to be enumerated among the ſecretions, which are peculiar to animals of this claſs.

(F) VERMES.

§ 155. The moſt remarkable ſecretions in this claſs take place in the teſtacea. There is one of theſe common to the whole claſs; viz. the formation of the calcareous matter of their ſhells[3], which takes place in a peculiar viſcus lying near the heart (*ſacculus calcarius* SWAMMERD. *glandula teſtacea* POLI.) The celebrated purple[4] colour is formed in ſome marine genera; as the

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[19] See LYONET, tab. 5. and 14.

[20] RÖSEL, tom. 4. tab. 29.

[1] See SWAMMERDAM's plates of the organ in the bee, tab 18 and 19.

[2] RICH. MEAD, *Opera Medica*, tom. 2. tab. 3.

[3] SWAMMERDAM, tab. 5. of the *Helix Pomatia*. POLI, tom. 2. tab. 20. of the *Venus Chione*, tab. 26. of the *Arca Piloſa*.

[4] See STRÖM of the *Buccinum Lapillus* in the 11th vol. of *Kiöbénh. Selſk. Skriſter*. p. 30.

Buccinum lapillus and *echinophorum*, *murex brandaris* and *trunculus*, *Helix ianthina*, *arca nucleus*, &c. Laſtly ſome bivalves, under extraordinary circumſtances form pearls[5] on the inner ſurface of their ſhell. (See note (K) for an account of the ſilk, ſecreted by molluſca, and note (L) for the ink of the cuttle fiſh.)

Additions to Chapter the Eleventh.

(A) This remarkable gland is found on the back of the animal, over the ſacrum. It is of a conſiderable ſize (between two and three inches long, and above and inch broad), and is compoſed of ſeveral lobules, whoſe ducts join into one canal, which penetrates the ſkin. It furniſhes a ſecretion of a very pleaſant muſk-like odour, from which TYSON denominated the animal *aper moſchiferus*. The opening of this part on the back has been deſcribed by many authors as the navel (BARTHOLIN. *Cent.* 2. *Hiſt. Med.* 96.)

TYSON in the *Philoſ. Tranſ.* No. 153, or in his *works*, London, 4to. 1751, with a good delineation of the gland.

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[5] Poli, tom. 1. Introduction, p. 19.

(B) Theſe anal bags are of a ſpherical form, and have a ſmall round opening juſt at the margin of the anus. They ſeem to belong particularly to the carnivorous animals. They may be ſeen very well in the cat. Their ſecretion poſſeſſes that ſtrong diſagreable odour, which characteriſes ſo remarkably many animals of this order, as the fox and all the weazel tribe; and which has even made the polecat proverbial in common language, and has beſtowed on it its ſcientific name, *muſtela putorius*. Some American ſpecies exceed the fetor even of the polecat. This is the caſe with the *viverra mephitica* and *coaſſe* (the ſkunk and ſquaſh). They pour out the fetid matter when purſued; and are thereby effectually defended, as neither man nor animal can approach them.

Theſe parts are not however confined to the carnivora, as ſeveral rodentia poſſeſs them.

(C) It is from theſe glands, and not from the teſticles, as naturaliſts have abſurdly ſuppoſed, that the ſubſtance called *caſtoreum* is produced. A delineation of the parts, from the diſſection of the Pariſian academicians, may be ſeen in the collection of Blasius. *Anatom. Animalium.* tab. 13.

That valuable article of the materia medica, *muſk*, is produced from ſimilar glands in the *moſchus moſchifer* (in Engliſh the muſk), an animal found in the mountains of Thibet, and the ſouthern parts of Siberia.

(D) I have already ſtated that ſalivary glands, in the proper ſenſe of the term, do not exiſt in birds; and that the parts which the author mentions here, muſt be regarded in a different point of view. (See the note to § 94.)

(E) Tyson ſtates that the oſtrich has this gland ſituated not on the rump, but further forwards, (Anatomy of the Mexican Muſk-hog, p. 39.) I have obſerved in the ſituation, which he mentions, a pretty conſiderable bag with hard callous ſides, and nothing glandular in its coats. It contained a brown and unctuous, but nearly ſolid matter, and I could diſcover no external opening; but it had been ſomewhat cut before I examined it. It cannot I think be very well compared with the oil bag of the rump.

(F) There is found in the crocodile, on each ſide of the lower jaw, and juſt under the ſkin, a gland, whoſe duct opens externally. It ſecretes a ſubſtance ſmelling like muſk.

(G) Cuvier repreſents the tubes which open in the courſe of the *linea lateralis* of fiſhes, as the excretory ducts of two glands placed above the orbits. *(Leçons d'Anat. compareè.)* tom. 5. p. 260.

In the *ſkate* the openings are not confined to any particular part, but are ſcattered over the ſurface. The tubes radiate from one point, juſt above the angle of the jaw; and the third branch of the fifth pair of nerves is diſtributed at that part; its filaments accompanying the tubes.

For an account of the electrical organs of fiſhes, which muſt be conſidered as parts ſecreting the electrical matter, ſee § 217: and for their ſwimming bladder, in which a ſecretion of air is effected, § 186.

(H) Almoſt all the larvæ or caterpillars ſpin for themſelves ſome kind of covering before their metamorphoſis; but it is the ſilkworm only *(bombyx mori)*, that furniſhes the materials of our various ſilk manufactures, as the thread which it forms is very pliant and abundant, and can be eaſily unrolled.

The ſecretory organs, which furniſh this matter of ſilk, are the ſame in all larvæ. They conſiſt of two long tubes, at firſt ſmall and tortuous, but growing gradually larger to form a kind of reſervoir, and terminating in a ſingle very ſmall tube, which opens under the lower lip. It is by moving its head from ſide to ſide, that the animal draws out the ſilk.

(I) In thoſe inſects, which poſſeſs ſtings, the irritating or poiſonous fluid is formed in a peculiar bag, which ſends a duct to the ſting. The latter part is hollow, and its tube opens externally. It is contained in a ſheath, and barbed at the ſides of its point, ſo that it uſually remains in the wound, which it inflicts. A delineation of theſe parts in a magnified view may be ſeen in SWAMMERDAM, tab. 27. of the Engliſh tranſlation.

(K) Several acephalous molluſca produce a kind of ſilk, ſimilar to that of the larvæ of inſects. It is ſometimes called the *beard ;* and is employed by the animal in order to attach itſelf to rocks, &c. It is formed by a conglomerate gland, placed near the foot ; which latter part draws out the ſilk from the excretory duct, and moulds it in a groove on its ſurface. The ſea muſcle (*mytilus*) the *pinna*, and *perna*, exemplify this ſtructure. The pinna produces it in ſuch quantity, and of ſuch quality, as to admit of its being manufactured into gloves, which is done at Meſſina and Palermo (BLUMENB. *handbuch der Naturgeſchichte.* ed. 6. p. 438.)

(L) The black inky fluid of the cuttle-fiſh, which has often been ſuppoſed to be the bile, is a very ſingular ſecretion, that muſt be noticed in this place. The bag, in which it is contained, has a fine callous internal ſurface, and its excretory duct opens near the anus. The fluid itſelf is thick, but miſcible with water to ſuch a degree, that a very ſmall quantity will colour a vaſt bulk of water; and the animal employs it in this way to elude the purſuit of its enemies. According to **Cuvier**, the *Indian ink* (which comes from China) is made of this fluid. (*Léçons d'Anat. Comp.* tom. 5. p. 262.)

THE

VITAL FUNCTIONS.

CHAPTER XII.

ON THE HEART AND BLOOD-VESSELS.

§ 156. A PERFECT circulating ſyſtem, to which on the one hand fluids are brought by the abſorbents, to be converted into blood; and from which on the other ſide, various juices are ſeparated in glands, and viſcera of a glandular ſtructure; appears to belong univerſally and excluſively to red-blooded animals. A pericardium exiſts in all theſe animals.[1] Parts of ſuch a ſyſtem, particularly a heart, and certain veſſels connected with it are found in ſome genera of the two white-blooded claſſes.

(A) MAMMALIA.

§ 157. The internal ſtructure of the heart is the ſame as in man; but its ſituation in quadrupeds and cetacea differs from that which it has in the human ſubject. It is in the former more lengthwiſe with reſpect to the body; reſting rather on the ſternum than on the diaphragm. Hence the pericardium of theſe animals is not connected with the diaphragm[2] as in the human ſubject; the portion of the inferior vena cava within the cheſt is proportionably longer.[3] (See note (D) at the end of the chapter.)

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[1] It is ſurpriſing that ſo many good anatomiſts ſhould have denied the exiſtence of a pericardium in the hedgehog. BLASIUS, PEYER, HARDER, TOZZETTI, &c. are among theſe. The membrane is indeed very delicate in this animal, and it requires ſome care to avoid tearing it in opening the cheſt.

§ 158. The larger adult biſulca, and the pig have two ſmall flat bones, (which have been called, particularly in the ſtag, *bones of the heart)* where the aorta ariſes from the left ventricle. The common notion that they ſerve as a ſupport to the valves,[4] does not much elucidate the ſubject. (See note (B).

§ 159. It has been ſuppoſed, that the amphibious animals of this claſs and the cetacea have an open *foramen ovale*, like that of the fœtus, in their ſeptum auricularum. And the neceſſity of ſuch an opening has been inferred from their way of life; ſince they often paſs a conſiderable time under water without breathing. This ſuppoſition has been fully refuted by the repeated diſſection of adult animals of this kind; which has ſhewn that an exception from the general rule very rarely occurs.[5] (See note (C).

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[2] See MORGAGNI in his *Epiſt. Anat.* p. 302, edit. 1764.

[3] On the proportionate length of the heart to that of the whole body. See T. H. BERGMAN, *Primæ lineæ Pathologiæ Comparatæ.* Gött. 1804, 4.

[4] C. I. KEUCHEN, *de Oſſiculis e Cordibus Animalium.* Groning. 1772, 4.

In ſeveral genera and ſpecies, of web-footed mammalia, and cetacea (that is, in the common and ſea-otters, in the dolphin, &c.) particular veſſels have been obſerved to be conſiderably and conſtantly enlarged, and tortuous. This ſtructure has been principally remarked in the inferior vena cava; where there can be no doubt that it ſerves, while the animal is under water, to receive a part of the returning blood, and to retain it until reſpiration can be again performed, and the leſſer[6] circulation be thereby again put in action.

§ 160. There are ſome remarkable circumſtances in the diſtribution of particular arteries in certain animals of this claſs. We may notice, as the moſt ſingular of theſe, the rete mirabile, formed by the internal carotid at its entrance into the cranium, in ſeveral ruminating biſcula[7], and carnivorous animals: and that diviſion of the arterial trunks of the extremities, which has been obſerved by Mr. CARLISLE[8] in the ſlow-moving animals, viz. the ſloths, and lemur tardigradus. The arteries of the arm and thigh in theſe caſes, divide as they leave the trunk into numerous parallel branches, which are united again towards the elbow and knee.* (See note (D).

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[5] I poſſeſs through the kindneſs of Dr. Albers, of Bremen a very ſingular heart of an adult ſeal. The *foramen ovale* and *ductus arterioſus* are completely open. Both the arterial trunks, and particularly the aorta, form large, and as it were aneuryſmatic expanſions. The ſame fact was obſerved by Seger in the latter veſſel in a ſeal, of which he has given an account in the *Ephem. Nat. Curios*, Dec. 1. an 9. p. 252.

[6] Kulmus in the *Acta Acad. Natur. Curios. tom. 1. p.* 25.

(B) BIRDS.

§ 161. The whole of this claſs without exception, poſſeſs a very remarkable peculiarity in the ſtructure of the heart. The right ventricle, inſtead of having a membranous valve (ſuch as are found in both ventricles of mammalia, and alſo in the left of birds), is provided with a ſtrong, tenſe, and nearly triangular muſcle. This ſingular ſtructure aſſiſts in driving the blood with greater force, from the right ſide of the heart into the lungs: ſince the expanſion of the latter organs by reſpiration, which facilitates the tranſmiſſion of the carbonated[9] blood in mammalia, does not take place in birds, on account of the connection which their lungs have with the numerous air-cells, which will be afterwards deſcribed.[10]

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[7] It is repreſented by MONRO in the ſlink calf. *Obſ. on the Nervous Syſtem, tab.* I.

[8] In the *Philos. Trans.* for 1800, p. 98.

* The moſt curious and elegant diſtribution of veins occurs in the foot of the horſe; where theſe veſſels run in innumerable parallel branches on the anterior ſurface of the coffin bone, and form a reticular plexus of anaſtomoſes on the under part which completely covers the ſurface of the bone.

(C) AMPHIBIA.

§ 162. The frogs, lizards, and ſerpents, of this country at leaſt, have a ſimple heart, conſiſting of a ſingle ventricle and auricle.[11] See note (E).

§ 163. The ſtructure of this part is very different in the turtle;[12] and has given riſe to more controverſy than that of any order of animals.

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[9] The reaſons which have induced me to ſubſtitute the terms, *carbonated* and *oxygenated*, for thoſe of venous and arterial blood have been explained in the *Inſtit. Phyſiol.* p. 13.

[10] I have ſpoken more largely of this part, in the *Comment. Reg. Soc. Scient.* Gotting. vol. 9, where there is alſo a repreſentation of the muſcle in the heron, p. 128.

[11] SWAMMERDAM gives the cleareſt repreſentation of the heart of the frog, and of the veſſels, which are moſt immediately connected with it, tab. 49.

[12] I have lately opened a tortoiſe from Morocco, which came to me alive, and for which I am alſo indebted to Dr.

Their

Their heart poſſeſſes two auricles,[13] which are ſeparated by a complete ſeptum, like thoſe of warm-blooded animals, and receive their blood in the ſame manner, as in thoſe animals; viz. the two venæ cavæ terminate in the right auricle, the pulmonary veins in the left. Each pours its blood into the correſponding ventricle, of which cavities there are two: thus the ſtructure of the heart hitherto reſembles that of mammalia.

The characteriſtic peculiarities, which diſtinguiſh the heart of theſe animals, conſiſt in two circumſtances. Firſt, both the ventricles communicate together; there is a muſcular, and as it were tubular

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Albers. The ſtructure of its heart, concerning which Morgagni himſelf was in doubt, exactly reſembled that of the turtle in the moſt important circumſtances: viz. in the union of the two ventricles by an intermediate opening, in the origin of the large arteries from the right ventricle, as well as in the diſtribution of the aorta, and the union of its two chief branches in the abdomen. The cavities of the ventricles were equally ſmall; their parietes equally ſpongy. The intermediate opening of the ventricles was more ſimple as it had not the valvular ſtructure, which is found in the heart of the turtle. The auricles were looſe and thin as in the *teſtudo caretta*; not ſtrong and ſpongy as in the *mydas*.

[13] A remarkable difference exiſts in the ſtructure of the auricles between the *teſtudo caretta* and *mydas*, both of whoſe hearts now lie before me. The auricles of the former are thin, like thoſe of warm-blooded animals; in the latter they are very firm, and have almoſt as thick and ſtrong parietes as the ventricles.

valve, going from the left to the right cavity, by means of which the former opens into the latter. Secondly, the large arterial trunks ariſe all together from the right ventricle only (no veſſel coming from the left). The aorta, forming three grand trunks[14], is ſituated towards the right ſide and the upper part; the pulmonary artery comes as it were from a particular dilatation[15], which is not ſituated in the middle of the baſis of the heart, but lower; (it muſt be underſtood, as we have already obſerved, that we apply theſe terms according to the horizontal poſition of the animal.)

We can now comprehend how this wonderful and anomalous ſtructure, by which all the blood is propelled from the right ventricle only, is accommodated to the peculiar way of life of the animal, which ſubjects it frequently to remaining for a long time under water. For the greater circulation is ſo far independent of that, which goes through the lungs, that it can proceed, while the animal is under water, and thereby prevented from reſpiring,

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[14] Two of theſe go to the abdomen; the right is the proper *aorta abdominalis*, the left is the *ductus communicativus* of MERY, who compared it to the *ductus arterioſus* of the fœtus

[15] MERY conſidered this dilatation as a third ventricle, *ventriculus intermedius*; hence it has happened, that ſome zootomiſts have aſcribed to the turtle a ſingle ventricle, (on account of the communication); ſome two, and others three.

although

although the latter is impeded. In warm-blooded animals, on the contrary, no blood can enter the aorta, which has not previouſly paſſed through the lungs, into the left ventricle; and hence an obſtruction of reſpiration moſt immediately influences the greater circulation[16].

(D) FISHES.

§ 164. The heart in this claſs of animals is extremely ſmall in proportion to the body. Its ſtructure is very ſimple, as it conſiſts of a ſingle auricle and ventricle, which correſpond with the right ſide of the heart in warm-blooded animals. The ventricle gives riſe to a ſingle arterial trunk (which is expanded in moſt fiſhes into a kind of bulb as it leaves the heart), going ſtraight forwards to the *branchiæ*, or organs of reſpiration. The blood paſſes from theſe into a large artery, analogous to the aorta, which goes along the ſpine and ſupplies the body of the animal. It is then returned by the venæ cavæ into the auricle[17].

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[16] The beſt and moſt intelligible delineations of the turtle's heart are thoſe by MERY in the *Mem. de l'Acad. des Sc.* 1703. Although he made an erroneous application of them to the courſe which he ſuppoſed the blood to take in the heart of the human fœtus. I conclude from a compariſon with my own preparations, that his drawings were taken from the *teſtudo caretta*.

§ 165. Moſt cold-blooded animals, as fiſhes, and the amphibia of this country, have a much ſmaller proportion of blood, and fewer blood-veſſels than thoſe with warm blood. On the contrary, they have a much greater number of *colourleſs veſſels* ariſing from the arterial ſyſtem.

(E) INSECTS.

§ 166. A true heart, and ſyſtem of veſſels connected with it, are found in a very few of what are called white-blooded animals. In this claſs they ſeem to belong only to ſome genera of inſects which have no wings; as the genus *cancer*,[19] and *monoculus*. Several of the older zootomiſts conſidered the dorſal veſſel of the larvæ, &c. to be a heart; but this opinion has been already refuted by LYONET. In the genera which we have mentioned, there ſeems to be no paſſage of the arterial extremities into the origins of veins, and conſequently no true circulation. (On the mode of nutrition in theſe animals, ſee note (F).

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[17] Repreſentations of the heart of a fiſh are given by PERRAULT in the *Eſſais de Phyſique*, tom. 4. tab. 19.: by DUVERNEY, in his poſthumous "*Œuvres Anatomiques*", tom, 2. tab. 9.: by GOUAN *Hiſtoria Piſcium*, tab. 4. (all theſe however call the trunk of the *branchial artery*, the *aorta*) and by MONRO in his "*Structure and Phyſiology of Fiſhes.*"

[18] In an experiment which I made on this ſubject, I obtained from 24 adult water-newts *(lacerta paluſtris)* which has been juſt caught, and weighed 1½ oz. three ſcruples and a half of blood. The proportion therefore of this fluid to the weight of the body was as 2½ to 36; while the ſame proportion in an adult and healthy man is as 1 to 5.

(F) VERMES.

§ 167. In many genera of this claſs, particularly among the *mollufca*[20] and *teſtacea*,[1] there is a very manifeſt heart[2], which is ſometimes of a ſingular ſtructure. It conſiſts, for inſtance, in the *cuttle-fiſh*, of one ventricle, and two auricles, which lie at ſome diſtance from the ventricle, near the gills.

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[19] WILLIS *De Animâ Brutorum*, tab. 3. fig. 1. RÖSEL'S *Inſects*, vol. 3, tab. 58.

[20] See SWAMMERDAM of the *limax maximus*, tab. 9. of the *ſepia officinalis*, tab. 52. MONRO *on Fiſhes*, tab. 31.

[1] See POLI *teſtacea utriuſque Siciliæ*, Vol. 1, and 2, for a repreſentation of this in ſeveral teſtacea. WILLIS in the work above quoted, tab. 2. of the *oyſter*. SWAMMERDAM, tab. 5, of the *helix pomatia*.

[2] CUVIER divides the whole claſs of *vermes*, according as they are furniſhed with a heart, and vaſcular ſyſtem, or are deſtitute of theſe organs, into two families: the former he calls *molluſca*, the latter *zoophita*.

Some bivalves are ſaid by POLI to have two auricles, and ſome even four. But in all theſe inſtances, there has been no connection hitherto diſcovered between the arteries and veins;[3] while on the other hand ſome genera in other orders of this claſs have a connected ſyſtem of veſſels without a heart;[4] and the proper *zoophytes* cannot be ſaid to poſſeſs either; as their nutrition ſeems to be effected by an immediate derivation of the nutritive fluid from their abdominal cavity into the gelatinous parenchyma of their body[5]. *

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[3] See POLI, tom. 2, tab. 25, of the *arca noæ*, and tab. 27, of the *oſtrea jacobæa*, alſo tom. 1, introduction, p. 39.

[4] B. F. BENING *de hirudinibus*. Harderov. 1776, 4to. a very excellent monograph. The *meduſæ* alſo have no heart, but a manifeſt circulating ſyſtem of arteries and veins. See MITCHILL in *Albers's American Annals*, in German, pt. 1. p. 121.

[5] SPALLANZANI, FONTANA, and MULLER, have conſidered the dark portion in the body of the wheel animal (*vorticella rotatoria*) to be a heart; although it has voluntary motion, which is influenced by that of the radi. And they have employed this by a curious *petitio principii*, to prove that there are animals which have a voluntary power of ſetting their heart in motion, or leaving it at reſt. I have ſhewn twenty-three years ago, that this remarkable organ can by no means be looked upon as a *heart*, but is really an *alimentary canal*.

* On the circulating ſyſtem of the vermes, ſee note (G) at the end of the chapter.

Addi-

Additional Notes to the Twelfth Chapter.

(A) The heart of the *orang outang* is placed obliquely like that of the human ſubject; but in other *ſimiæ* the apex only is a little inclined to the left, and juſt touches the diaphragm.

(B) The right auricle receives in the *porcupine* and *elephant* two anterior venæ cavæ; the left of which opens near the communication with the ventricle.

(C) The queſtion, whether or no the *foramen ovale* be open in ſuch animals, as have the power of diving, and remaining for ſome time under water, ſeems to be as yet not completely decided. In addition to the affirmation of the author, § 159, the evidence of CUVIER may be quoted; he ſtates that in ſeveral *porpoiſes*, in a *dolphin*, and a *ſeal*, he found this opening cloſed. (*Léçons d'Anat, Comp. tom.* 4. p. 201.) The Pariſian diſſectors alſo found it cloſed in a *beaver*. (*Deſcription Anatom. d'un caſtor.* &c. p. 68.) It was perfectly ſhut in a *porpoiſe* and young *ſeal* which I examined: and according to Mr. HOME, (*Philoſ. Tranſ.* 1802) it is cloſed in the *ornithorhynchus*. On the other ſide of the queſtion, beſides the fact mentioned in note 5, which is very ſtriking, we may adduce Mr. HOME's authority for the exiſtence of the foramen ovale, in an open ſtate, in the *ſea otter*. He found it ſo in two inſtances; one of which was in an adult animal. But the *ductus arterioſus* was cloſed. (*Philoſ. Trans*. 1796, pt. 2). This may perhaps be nothing more than a caſual occurrence; as a ſmall opening is not unfrequent in the human ſubject; and I lately met with the communication as free as in the fetal ſtate, in a perſon, who had no ſymptom of diſeaſe, or defect in the circulating ſyſtem during life.

(D) Plexuſes or convolutions of the arteries are found in ſome parts of the cetacea; as in the intercoſtal arteries, in the branches which go from the ſubclavian to the cheſt, in thoſe which ſupply the medulla ſpinalis, and the eye. HUNTER in the *Philoſ. Tranſ*. 1789, pt. 2.

(E) The account which CUVIER gives of the anatomy of the heart in the amphibia, does not exactly accord with that of the author. CUVIER deſcribes and delineates the heart of the crocodile as being formed nearly like that of the turtle (tom. 5. pl. 45); he ſays that the iguana has a ſimilar ſtructure, and that it obtains likewiſe in the ſerpents, (tom. 5. p. 221-225.) He does not mention the more ſimple form as exiſting in any lizard or ſerpent.

(F) It appears that inſects poſſeſs neither blood-veſſels, nor abſorbents. CUVIER has examined, by means of the microſcope, all thoſe organs in this claſs, which in red-blooded animals are moſt vaſcular without diſcovering the leaſt appearance of a blood-veſſel; although extremely minute ramifications of the tracheæ are obvious in every part. And LYONET has traced and delineated in the caterpillar, parts infinitely ſmaller than the chief blood-veſſels muſt be, if any ſuch exiſted. *Anatomie de la Chenille*, &c.

Yet inſects, both in their perfect, and in their larva ſtate, have a *membranous tube* running along the back, in which alternate dilitations and contractions may be diſcerned. From this circumſtance it has been ſuppoſed to be the heart; but it is cloſed at both ends, and no veſſels can be perceived to originate from it.

It is obvious from theſe data, that the functions of nutrition and ſecretion muſt be performed, in the animals which we are now conſidering, in a very different manner from that which obtains in the more perfect claſſes. CUVIER expreſſes the mode, in which he ſuppoſes growth and nutrition to be effected, by the term "*imbibition.*" And he explains from this circumſtance, the peculiar kind kind of reſpiration, which inſects enjoy. Since the nutritive fluids have not been expoſed to the atmoſphere, before they arrive at the parts for whoſe nouriſhment they are deſtined; this expoſure is effected in the parts themſelves, by means of the air-veſſels, which ramify moſt minutely over the whole body. "En un mot, le ſang ne pouvant aller chercher l'air, c'eſt l'air, qui va chercher le ſang." (*Leçons d'Anat. Comp.* l. 23, ſect. 2, art. 5).

The heart of the *cruſtacea* according to Cuvier has no auricle; and it is what he calls an *aortic heart.* For it expels the blood into the arteries of the body; and this fluid paſſes through the gills previouſly to its reaching the heart again. The different parts of the ſyſtem are here found under a mode of connection exactly the reverſe of what we obſerve in fiſhes; where the blood is ſent into the gills, and paſſes ſubſequently into the aorta. The circulating organ in that claſs is therefore a *pulmonary heart.*

I do not comprehend what the author means by ſtating, that there is no communication between the arteries and veins in the cruſtacea. If the blood is ſent out in the one ſyſtem of veſſels, and returns by the other; does not this prove the communication?

(G) According to Cuvier, the cuttle-fiſh has three hearts, neither of which poſſeſſes an auricle. Two of theſe organs are placed at the root of the two *branchiæ:* they receive the blood from the body, (the vena cava dividing into two branches, one for each lateral heart) and propel it into the branchiæ. The returning veins open into the middle heart; from which the aorta proceeds.

The other molluſca have a ſimple heart, conſiſting of one auricle and ventricle. The vena cava aſſumes the office of an artery, and carries the returning blood to the gills; whence it paſſes to the auricle; and is ſubſequently expelled into the aorta. Here therefore, as in the cruſtacea, the heart is a *pulmonary* one.

The *vermes* of CUVIER have circulating veſſels, in which contraction and dilatation are perceptible; without any heart. They can be ſeen very plainly in the *lumbricus marinus*. The *leech*, *naias*, *nereis*, *aphrodite*, &c. are further examples of the ſame ſtructure. This anatomiſt is of opinion that the *mollusca*, *cruſtacea*, and *vermes*, poſſeſs no abſorbing veſſels; and he thinks that the veins abſorb, as he finds them to have communication with the general cavity of the body, particularly in the cuttle-fiſh. Hence the above mentioned claſſes will hold an intermediate rank, between the *vertebral animals*, which poſſeſs both blood-veſſels, and abſorbents; and the *inſects* which have neither. (*Leçons*, &c. l. 23. ſect. 2. art. 4).

CHAPTER XIII.

OF THE ABSORBING VESSELS.

§ 168. IT was regarded as an axiom even by **Valsalva**, that thoſe animals, which have true blood-veſſels, have alſo an abſorbing or lymphatic ſyſtem. It appears alſo that the converſe of this propoſition is true: viz. that thoſe claſſes only have true lymphatic veſſels, which poſſeſs at the ſame time a perfect circulating ſyſtem of blood-veſſels; that is, only the four claſſes of red-blooded animals.

In many of what are called white-blooded animals, there is a kind of abſorption very evident; as in the armed polypes, whoſe parenchyma becomes tinged in a ſhort time with the colour of thoſe inſects, which have been ſwallowed. The exiſtence of abſorption is inferred by analogy from other phœnomena, as the metamorphoſis of larvæ, &c. But no true ſyſtem of real abſorbing veſſels has been hitherto demonſtrated in theſe animals[1].

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[1] **Sheldon** has aſcribed abſorbing veſſels to the ſilk-worm and other larvæ: ſee his hiſtory of the abſorbent ſyſtem. Part I. p. 28.; and **Monro** to the *echinus eſculentus* (ſea hedge-hog) in his *Phyſiol. of Fiſhes*. p. 88.

§ 169.

§ 169. This ſyſtem (which comes moſt properly under conſideration in the preſent chapter, on account of its relation to the circulation of the blood), conſiſts of the *lacteal* veſſels, which ariſe from the ſmall inteſtines, and of the proper *lymphatic* veſſels, which belong to the reſt of the body. It includes alſo the *conglobate glands*, which are found in moſt of the animals, which have this ſyſtem, and ſeem to conſiſt merely of a congeries of the veſſels; and laſtly, the *thoracic duct*, which is the chief canal for conveying the fluids from the lymphatic ſyſtem into the blood. (See note (A) at the end of the chapter.)

(A) MAMMALIA.

§ 170. All the parts of the abſorbing ſyſtem, which have been juſt enumerated, are moſt perfect and manifeſt in this claſs of animals[2]. When their lacteals contain chyle, they are diſtinguiſhed by their white colour from the other abſorbing veſſels, the contents of which are either limpid, or of a ſlight yellow tinge. The former veſſels run together in conſiderable trunks, particularly in the ſheep and goat: the latter, or true lymphatics, may be ſeen to advantage on the hind-leg of the horſe, where they follow a tortuous courſe.

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[2] It is well known that all the chief parts of this important ſyſtem of veſſels have been firſt diſcovered in mammalia.

The thoracic duct is double in ſome quadrupeds[3], as in the dog, and forms at its commencement, more conſtantly than in the human ſubject, a veſicular enlargement, called the *ciſterna* or *receptaculum*[4] *chyli.* (See note (B).

In many mammalia, particularly of the order *feræ*, the meſenteric glands are collected into one maſs, which is known by the inappropriate name of *Pancreas Aſellii*[5].

(B) BIRDS.

§ 171. The chyle is tranſparent in this claſs; therefore the lacteals are only diſtinguiſhed from the lymphatics by their ſituation and office. There are no glands in the meſentery, although conglobate glands are found in other parts in ſeveral of the larger birds. Their thoracie duct is double[6].

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[3] PECQUET *Experimenta Nova Anatomica*, p. 21. Ed. of 1654.

[4] The courſe and diſtribution of the thoracic duct vary in quadrupeds, at leaſt in our domeſtic animals, as much as in the human ſubject. It forms not unfrequently, in the dog, a kind of annular portion at its upper, or more properly, anterior and, which trivial variety VAN BILS transformed into a conſtant and important circumſtance, and called "*receptaculum tortuoſum*," &c. He has repreſented it in a very beautiful plate, as far as the engraving goes, in his *Reſponſio ad Admonitiones* JO. AB. HORNE. Roterod. 1661. 4. p. 7.

[5] ASELLIUS *de lactibus*. tab. 1, and 2.

(C) AMPHIBIA.

§ 172. Lacteals are found in great number in the delicate meſentery of the turtle. The thoracie duct is double. There ſeem to be no lymphatic glands at all[7]. (See note (C).

(D) FISHES.

§ 173. The lymphatics of theſe animals ſeem to be deſtitute of glands and valves: they want alſo the lymphatic glands, and their thoracic duct divides at leaſt towards its anterior part, into two chief branches[8].

Additional Notes to the Thirteenth Chapter.

The ſtructure and offices of the abſorbent glands have been illuſtrated by the obſervations of Mr. ABERNETHY on the formation of theſe parts in the whale. He found the meſenteric glands of that animal to conſiſt of large ſpherical bags, into which ſeveral of the lacteals opened. Numerous veſſels ramified on theſe cyſts; and the injection paſſed from their ſecerning extremities into the cavity. In the groin and axilla of the horſe he alſo found them to conſiſt of one or more cells. Hence there can be no doubt that the abſorbed fluid muſt receive an addition in its paſſage through theſe bodies. *Philoſ. Tranſ.* 1796. pt. 1.

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[6] HEWSON in the *Philoſ. Tranſ.* vol. 57. tab. 10. of the *cock.*

[7] MONRO's *Phyſiol. of Fiſhes*, tab. 30.

[8] HEWSON and MONRO in the works quoted above. See alſo BARTHOLIN, *Anat. renov.* p. 609, of the *Cyclopterus Lumpus* (Lumpſucker).

It has been much queſtioned, whether the lymphatics have any communication with the venous ſyſtem, prior to the termination of the thoracic duct. The obſervations of that ingenious veterinary ſurgeon, Mr. BRACY CLARK, have determined this queſtion in the affirmative; as he has found the trunk of the lymphatic ſyſtem to have ſeveral openings into the lumbar veins in the horſe. REES's *Cyclopædia*, article ANATOMY VETERINARY.

(B) Mr. HOME has found that in the *ſea-otter* the receptaculum chyli ſends two trunks to form the thoracic duct. Theſe have frequent communications; ſo that there are ſometimes three, frequently four, and never fewer than two trunks running parallel to each other. *Philoſ. Tranſ.* 1796, pt. 2.

(C) The diſtribution of the lymphatics on the inteſtine of the turtle forms one of the moſt elegant preparations in comparative anatomy. By fixing the injecting tube in a veſſel near the inteſtine, and waiting with a little patience, the quickſilver will gradually find its way into the minute ramifications of the lacteals. The peritoneal ſurface of the gut is covered with very minute ſtraight parallel branches, running according to the length of the inteſtine. Its inner ſurface is no leſs thickly covered with lacteals of a different appearance. When dried it ſeems as if the quickſilver were contained in ſmall cells, covering the whole internal ſurface of the inteſtine ſo completely that the point of a pin could ſcarcely be placed between them.

CHAPTER XIV.

ON THE ORGANS OF RESPIRATION.

§ 174. THE inceſſant continuation of the great chemical proceſs, by which *oxygen*, the true pabulum vitæ, is exchanged for *hydrogen* and *carbone*, is eſſentially necſſary to the wellbeing of the greater part of animals. Yet the organs and mechaniſm, by which this wonderful function is carried on, vary very conſiderably[1]. In the mammalia after birth; in birds, when they have left the egg; and in amphibia when completely formed, the chief organ of this function is the *lungs*: in fiſh it is performed in the *gills*; in moſt inſects, in their *tracheæ*; in the vermes, in analogous, but at the ſame time very different parts.

(A) MAMMALIA.

§ 175. The lungs of quadrupeds agree on the whole in ſtructure, form and connection, with thoſe of the human ſubject. In the cetacea on the contrary, and in the web-footed mammalia, (as the *manati)*, which approach moſt nearly to them, they are diſtinguiſhed by a firmer texture, particularly of the inveſting membrane, and by their peculiar form; ſince they are not divided into lobes, but have an elongated and flattened appearance. They are adherent to the pleura, as well as to the very ſtrong and muſcular diaphragm[2].

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[1] AUG. BROUSSONET *Variæ Poſitiones circa Reſpirationem.* Monſpel. 1778, 4. it is alſo contained in LUDWIG's *Delectus Opuſculor. ad Scient. Naturalem ſpectant.* Lipſiæ, 1790, 8. p. 118.

(B) BIRDS.

§ 176. The reſpiratory organs of this claſs conſtitute one of the moſt ſingular ſtructures in the animal economy, on account of ſeveral peculiarities, which they poſſeſs; but more particularly in conſequence of their connection with the numerous air-cells, which are expanded over the whole body[3].

The lungs themſelves are comparatively ſmall, flattened, and adhering above to the cheſt, where they ſeem to be placed in the intervals of the ribs; they are only covered by the pleura on their under ſurface, ſo that they are in fact on the outſide of the cavity of the cheſt, if we conſider that cavity as being defined by the pleura*: a great part of the thorax, as well as the abdomen is occupied by the membranous air-cells[4], into which the lungs open by conſiderable apertures. Thoſe of the thorax are divided, at leaſt in the larger birds, by membranous tranſverſe septa, into ſmaller portions[5]; each of which, as well as the abdominal cells has a particular opening of communication with the air-cells of the lungs, and conſequently with the trachea. The membranes of theſe cells in the larger birds are provided here and there with conſiderable faſciculi of muſcular fibres, which have been regarded as a ſubſtitute for the diaphragm, which is wanting in this claſs of animals[6]. They alſo ſerve very principally, as we may aſcertain by examining large birds in a living ſtate[7], to drive back again into the lungs, the air which they received in inſpiration; whence the repletion and depletion of the thoracic cells muſt alternate with thoſe of the abdominal cavities[8].

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[2] TYSON'S *Anatomy of a Phocæna*. p. 30.

[3] LADISL. CHERNAK *de Reſpiratione Volucrum*. 1773, 4to.

* See note (A) at the end of the chapter.

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[4] Diſcovered by HARVEY, "*De Generatione Animalium.*" p. 4.

[5] PERRAULT *Eſſais de Phyſique*, tom. 3, tab. 18. of the oſtrich.

[6] CASP. BARTHOLIN *Diaphragmatis Structura Nova.* Paris, 1676, 8, p. 31. Modern zootomiſts have been divided on this queſtion; which of the membranes, in or about the cheſt of the bird, can be properly compared to the diaphragm. See J. HUNTER in the *Philoſ. Tranſ.* vol. 64, pt. 1, p. 207. And MICH. GIRARDI in the "*Memoirs of the Italian Society*," in Italian, tom. 2, pt. 2, p. 739.

[7] WEPFER *Cicutæ Aquaticæ Hiſtoria*, p. 171.

§ 177. Beſides theſe cells, a conſiderable portion of the ſkeleton is formed into receptacles for air, in moſt birds (for there are indeed exceptions and conſiderable variations in the different genera and ſpecies). This ſtructure is particularly marked in the larger cylindrical bones, as the ſcapula, clavicle and femur. It is alſo found in moſt of the broad and multangular bones of the trunk, as the ſternum, oſſa innominata, dorſal vertebræ, &c. All theſe are deſtitute of marrow[9] in the adult bird, at leaſt in their middle; ſo that the cylindrical bones form large tubes, which are only interrupted towards the extremities, by a ſort of tranſverſe bony fibres: the broad bones are filled with a reticulated bony texture, the cells of which are empty. They have conſiderable apertures[10] (moſt eaſily ſhewn in thoſe extremities of the cylindrical bones, which are turned towards the ſternum) communicating with the lungs by ſmall air-cells; which facts may be ſhewn by various experiments on living and dead birds[11].

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[8] J. B. Du Hamel *Hiſtoria Academ. Reg. Scient.* p. 141.

[9] This fact was known to the Emperor Frederic 2nd. See his treatiſe *de Arte Venandi cum Avibus*, p. 39, of Schneider's edition.

[10] Campers' *ſmaller writings*, in German, vol. 1. pt. 1. tab. 1, and 4.

Theſe receptacles of air probably ſerve the purpoſe of lightening the body of the bird in order to facilitate its motions. This effect is produced in moſt birds to aſſiſt their flight[12]; in ſome aquatic ſpecies, for the purpoſe of ſwimming; in the oſtrich and ſome others, for running. Hence we find the largeſt and moſt numerous bony cells in birds which have the higheſt and moſt rapid flight, as the eagle, &c. And hence alſo the bones of the bird which has juſt left the egg, are filled with a bloody marrow, which is abſorbed ſoon after birth, entirely in ſome, in others, particularly among the aquatic ſpecies, at leaſt for the greater part.

We may however conclude on the other hand, that all theſe bony receptacles of air are not, like thoſe of the thorax and abdomen, immediately connected with the reſpiration of the animals. For in many birds the interval between the two tables of the cranium contains air, while the apertures for its admiſſion are not connected with the lungs, but merely with the Euſtachian tube.

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[11] There are ſome curious experiments on this ſubject by Dr. ALBERS. He made living birds reſpire the different gaſes through the air-cells of their bones by means of an apparatus invented for the purpoſe. See his "*Contributions to the Anatomy and Phyſiology of Animals*," in German, pt. I. Bremen, 1802. 4. p. 110.

[12] WILLIS *de Anima Brutorum*, p. 30.

§ 178. The immenſe bill of ſome birds, which are for that reaſon called *leviroſtres*, is provided with air from the ſame quarter. This ſtructure is not therefore connected, as ſome anatomiſts [13] have ſuppoſed, with the organ of ſmelling, but forms a part of the air-cells.

§ 179. Laſtly the barrels of the quills alſo contain air[14]. Theſe are filled, in the bird which has juſt quitted the egg, with a bloody marrow; but they become hollow after its abſorption, and can be filled with air, or emptied at pleaſure. Hence ariſes the quick and voluntary erection of the plumage in the *turkey*, *bullfinch*, &c. (See note (B).

§ 180. Beſides the uſes, which have been already pointed out, theſe receptacles of air diminiſh the neceſſity of breathing frequently in the rapid and long continued motions of ſeveral birds, and in the great vocal exertions of the ſinging birds[15]. They are alſo obviouſly ſerviceable in the evacuation of the fæces, and probably aſſiſt in the expulſion of the egg.

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[13] CAJET. MONTI in the *Comment. Inſtit. Bonon.* tom. 3. p. 298.

[14] *Manual of Natural Hiſtory*, 1ſt edit. p. 154.

[15] WILLIS *de Anima Brutorum*, p. 30.

(C) AMPHIBIA.

§ 181. The lungs of amphibia[16] are diſtinguiſhed from thoſe of warm-blooded animals, both by a great ſuperiority in point of ſize, as well as by a greater looſeneſs of texture[17]: which circumſtances are ſerviceable in ſwimming in many of theſe animals. (See note (C).

§ 182. They have numerous projecting proceſſes in the chameleon[18]; and terminate behind in an elongated bladder in the newt. The ſerpents, at leaſt for the moſt part, have only a ſingle lung, which forms an elongated bag[19].

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[16] Thoſe of the teſtudines are delineated by CALDESI, in his "*Obſervations*," &c. tab. 8.

[17] It is well known, that the lungs of turtles and frogs do not collapſe on opening the animals, like thoſe of mammalia, but often remain expanded, at leaſt partially, for ſome time. MALPIGHI, and lately TOWNSON, (*de Amphibiis*, Goett. 1794-4,) have explained this phenomenon by the action of the conſtrictor muſcles of the glottis. BREMOND thought this inſufficient according to his experiments; and aſcribed much effect to the peculiar vitality of the lungs. See alſo on the ſame ſubject RUDOLPHI's experiments in his *Anatomico-Phyſiological Tranſactions*, p. 119.

[18] VALLISNIERI's "*Hiſtory of the Cameleon*," in Italian. p. 68, tab. 3.

[19] In a coluber of four feet and a half long, the lung meaſured one foot, one inch; its anterior half reſembled a muſ-

§ 183. In the tadpole, and the young of ſuch lizards as bring forth in water[20], there are two organs, which ſomewhat reſemble the gills of a fiſh (*appendices fimbriatæ* SWAMMERDAM)[1]. They are connected to the ſides of the neck, and hang looſe from the animal; they are not permanent, but are gradually withdrawn into the cheſt, (within a few days, in the reptiles of this country), where their remains may ſtill be perceived for ſome time[2] near to the true lungs[3]. Inſtead of the branchial opening, by

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cular inteſtine in appearance, and had an elegantly reticulated internal ſurface (which reſembled on a ſmall ſcale, the inner ſurface of the ſecond ſtomach of the ruminating animals). The poſterior part formed merely a ſimple and long cavity with thin ſides.

[20] It has been doubted whether the young of the true ſalamander are provided with theſe appendices; and LATREILLE, in his "*Hiſtoire Naturelle des Salamandres de France*," p. 19, and ſeq. has the following queſtion "*Les jeunes Salamandres Terreſtres ont elles des Branchies? voila une Queſtion que je mets encore au rang des Problemes*" I anſwered this queſtion in the affirmative fifteen years ago; having obſerved that the young of ſome pregnant ſalamanders, whom I kept in my room in glaſſes, and who brought forth under my inſpection, had conſiderable branchial appendices. See the *Specimen Phyſiologiæ comparatæ* in the 8th vol of the *Göttingen Commentaries*.

[1] *Biblia Naturæ*, p. 822. RÖSEL tab. 2. fig. 18.

[2] SWAMMERDAM, loc. citat. ROSEL, p. 82, tab. 19, fig. 2.

[3] That doubtful animal the *ſiren lacertina* from Carolina, has, according to HUNTER's diſſection, two bladder-like lungs, beſides the external branchiæ. *Philoſ. Tranſ.* vol. 65, p. 307.

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by which fiſhes again diſcharge the water, which they have taken in at the mouth, ſome tadpoles have for this purpoſe a canal on the left ſide of the head near the eye[4]; which muſt be diſtinguiſhed from the ſmall tube on the lower lip, by which they attach themſelves to aquatic plants[5].

(D) FISHES.

§ 184. Inſtead of *lungs*, this claſs of animals is furniſhed with *gills* or *branchiæ;* which are placed behind the head, on both ſides, and have a moveable gill cover *(opurculum branchiale)*, which is wanting in the order of *piſces chondropterygii* only. By means of theſe organs, which are connected with the throat, the animal receives its oxygen from the air contained in the water[6]; as thoſe animals which breathe, derive it immediately from the atmoſphere.

The ſame circumſtance holds good reſpecting that no leſs myſterious creature, the *proteus anguinus*, from the Cirknitz or Sitticher lake of Carniola; whoſe remarkable internal ſtructure has been deſcribed and delineated by Dr. SCHREIBERS in the *Philoſ. Tranſ.* for 1801.

[4] RÖSEL, tab. 18, fig. 7, 8. This organ is very conſpicuous in the large larvæ of the *rana paradoxa.*

[5] RÖSEL, tab. 14. fig. 17.

[6] This has been noticed by MAYOW, whoſe wonderfully acute genius penetrated the myſtery of the chemical proceſs of reſpiration *De Thermis Bathonienſibus* in his *Tractatus Medicophiſici*, p. 1, p. 259.

They afterwards diſcharge the water through the branchial openings (*aperturæ branchiales*); and therefore they are diſtinguiſhed from animals of the three preceding claſſes by this circumſtance; viz. that they do not reſpire by the ſame way that they inſpire.

§ 185. We have already ſhewn (§ 164) how the gills receive the venous blood by means of the branchial artery, and how this blood is ſent into the aorta after its converſion into the arterial ſtate. The diſtribution of theſe veſſels on the folds and diviſions of the gills conſtitutes one of the moſt delicate and minute pieces of ſtructure in the animal economy[7].

Each of the gills conſiſts in moſt fiſhes [8] of four diviſions, reſting on the ſame number of arched portions of bone or cartilage, connected to the os hyoides. Generally there is only a ſingle opening for the diſcharge of the water; but in many caſes, particularly among the cartilaginous fiſhes, there are ſeveral.

§ 186. Many animals of this order poſſeſs a ſingle or double ſwimming bladder[9]; which, at leaſt in the fiſhes of this country, contains azotic gas. It has not been hitherto determined, whether it be ſurſervient to any other functions, beſides that well-known one, from which its name is derived. In the mean time, like the air-receptacles of birds it may be conſidered without impropriety in the preſent diviſion of the work.

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[7] FISCHER's *Fragments of Natural Hiſtory*, vol. 1, p, 213.

[8] It is repreſented by MONRO in the *haddock* and *ſalmon*, tab. 25 and 26.

[9] See GOTT. FISCHER *on the ſwimming Bladder of Fiſhes*. Leipzig,

It is placed in the abdomen, and cloſely attached to the ſpine. It communicates generally with the œſophagus, and ſometimes with the ſtomach; by a canal *(ductus pneumaticus)*, containing in ſome inſtances, as the carp, valves which ſeem to allow the paſſage of air from the bladder, but not to admit its entrance from without.

(E) INSECTS.

§ 187. That white-blooded animals indiſpenſably require a ſpecies of reſpiration, would have been inferred by analogy from the wonderful apparatus of gills or tracheæ, which have been diſcovered in moſt orders of both claſſes of theſe beings. But in many caſes direct proof has been obtained on this

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Leipzig, 1795, 8vo. and additions to it in his *Fragments of Natural Hiſtory*, vol. 1, p. 229, &c In both theſe works he delineates the bladders of ſeveral fiſhes. Repreſentations of ſeveral others may be ſeen in NEEDHAM *de Formato Fœtu*, tab. 7. REDI, *de Viventibus intra Viventia*, tab. 3, 6. and the *Obſ. Anat. Collegii privati Amſtelod*, pt. 2. tab. 10.

point: experiment has actually proved the exchange of carbone for oxygen[10].

White-blooded animals are moreover diſtinguiſhed from thoſe which have red-blood, by this circumſtance; that none of the former, as far as we hitherto know, take in air through the mouth.

§ 188. Many aquatic inſects[11] as the genus cancer have a ſpecies of gills[12] near the attachment of their legs. The others, and particularly the land-inſects, which conſtitute, as is well known, by far the greateſt number of this claſs of animals, are furniſhed with air-veſſels, or tracheæ, which ramify over moſt of their body. Theſe tracheæ are much larger and more numerous in the larva ſtate of ſuch inſects, as undergo a metamorphoſis, (in which ſtate alſo the proceſs of nutrition is carried on to the greateſt extent) than after the laſt, or, as it called, the perfect change has taken place.

§ 189. A large air-tube *(trachea)* lies under the ſkin on each ſide of the body of larvæ, and opens externally by nine apertures *(ſtigmata)*: it produces on the inſide the ſame number of trunks of air-veſſels *(branchiæ)*, which are diſtributed over the body in innumerable ramifications [13].

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[10] See the two following very valuable works: F. L. A. SORG, *Diſquiſitio Phyſiologica circa Reſpirationem Inſectorum et Vermium* And FR. HAUSSMANN *Tentamen ſolutionis a Societat. Reg Scientiar. Gotting. circa Reſpirationem Inſectorum propoſitæ Queſtionis.*

[11] I. F. MARTINET *de Reſpiratione Inſectorum.* Lugd. Batav. 1753-4.

[12] They are repreſented in the *crawfiſh* by WILLIS *de Anima Brutorum*, tab. 3, fig. 2 and 3. And in RÖSEL's *Inſectenbeluſtigungen*, part 3, tab. 58, fig. 9, 11. tab. 59, fig. 17.

Both the tracheæ and branchiæ are of a ſhining ſilvery colour; and their principal membrane conſiſts of ſpiral fibres. The moſt numerous and minute ramifications are diſtributed on the alimentary canal; particularly on the above-mentioned corpus adipoſum. (§ 126).

§ 190. There is great variety in the number and ſituation of the external openings, by which inſects receive their air[14].

In moſt inſtances the ſtigmata are placed on both ſides of the body. The atmoſpheric air enters by an opening at the end of the abdomen in ſeveral aquatic larvæ, and even perfect inſects. A very remarkable change in this reſpect takes place in ſeveral animals of this claſs during their metamorphoſis. Thus in the larva of the common gnats (*culex pipiens*), the air enters by an opening on the abdomen: while in the nympha of the ſame animal, it gains admiſſion by two apertures on the head [15].

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[13] LYONET *Anatomie de la Chenille*, &c. tab. 4, 5, 6, 7, 10 and 11. The ſame organs have been repreſented by SWAMMERDAM in the *Scarabæus Naſicornis*, tab. 29, fig. 9, 10, tab. 30, fig. 1, 10. In the *lucanus cervus* (ſtag-beetle) by MALPIGHI *de bombyce*, tab. 3, fig. 2. in a *cicada* ibid. fig. 3. In a *gryllus* (graſshopper) ibid. tab. 4. fig. 1. alſo by CUVIER in the *Mem. de la Soc. d'Hiſt. Naturelle* de Paris, an. 7. p. 39. In the ſilk-worm by MALPIGHI, tab. 3, fig. 1. In a *libellula* by CUVIER, in the work juſt quoted, fig. 2, 5, 6. In the *ephemera* by SWAMMERDAM, tab. 14, fig. 1. tab. 15, fig. 1, 4 7. In the bee, ibid. tab. 17, fig. 9, 10. tab. 25, fig. 10. tab. 24, fig. 1, 2, 3. In the *æſtrus bovis* by Mr. B. CLARK *in the Tranſact. of the Linnean Society*, vol. 3, tab. 23, fig. 25. In the maggot of the fly by SWAMMERDAM, tab. 40, 41, 42, 43. In the louſe ibid. tab. 1, fig. 8, 4, 7.

[14] See the work above quoted, by HAUSSMANN.

(F) VERMES.

§ 191. In this claſs, which comprehends ſuch very different animals, the ſtructure of the reſpiratory organs is proportionally various [16]. Some orders, as thoſe which inhabit corals, the proper zoophytes, and perhaps the inteſtinal worms, appear to be entirely deſtitute of theſe organs; ſo that if any vital function, analogous to reſpiration, is carried on in theſe animals, it muſt be effected by methods which yet remain to be diſcovered.

§ 192. Thoſe vermes, however, which are furniſhed with proper organs of reſpiration, have the ſame variety in their ſtructture, which was remarked in inſects. Some, as the *cuttle fiſh*[17], *oyſter*[18], &c. have a ſpecies of gills, varying in ſtructure in different inſtances. But the greateſt number have air-veſſels or tracheæ.[19] Several of the teſtaceous vermes have both kinds of reſpiratory organs. In ſome of the inhabitants of bivalve ſhells, as the genus *venus*[20], the air-veſſels lie between the membranes of a ſimple or double tubular canal, found at the anterior part of the animal, and capable of voluntary extenſion and retraction. It ſerves alſo for other purpoſes, as laying the eggs. The margins of its mouth are beſet with the openings of the tracheæ. See note (E).

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[15] SWAMMERDAM *algem. verhandel. Van de Bloedeloofe Dierkens*, tab. 2.

[16] The reader may conſult on this ſubject, CUVIER in the *Journal d'Hiſtoire Naturelle*, 1792, tom. 2, p. 85. and in his *Tableau d'Hiſtoire Naturelle des Animaux*, p. 384. alſo SORG and HAUSSMANN in their works quoted above. And SPALLANZANI *Mémoires ſur la Reſpiration*. Geneve, 8vo, 1803.

Additional Notes to the Fourteenth Chapter.

(A) The cartilaginous annuli of the trachea, which are in general more complete, in the other mammalia, than in man, are perfect circles in birds, and overlap each other at their upper and lower margins. Hence the diameter of this part is not affected by any twiſting motion of the neck.

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[17] SWAMMERDAM, *Biblia Naturæ*, tab. 51, fig. 1. MONRO, tab. 4 , fig. 1. And particularly Dr .C. F. G. TILESIUS *de Reſpiratione Sepiæ Officinalis*. Lips. 1801-4, tab. 1, 2.

[18] WILLIS, tab. 2.

[19] Examples of this ſtructure in teſtaceous vermes may be ſeen in the *lepas balanus* (acorn-ſhell) Poli, tab. 4, fig. 20, 22. In the *pholas dactylus* (pierce-ſtone) ibid. tab. 8, fig. 61. In the *ſolen ſtrigilatus* (razor-ſhell), tab 13, fig. 5. In the *helix pomatia* (ſnail), SWAMMERDAM, tab. 4, fig. 1.

The common ſlug affords an inſtance in the molluſca, ſee SWAMMERDAM, tab. 8, fig. 7, tab. 9, fig. 1, and the leech in the inteſtinal worms, BENING, *de Hirudinibus*, p. 20.

[20] In the *venus læta*, POLI, tab. 2, fig. 17.

The air-veſſels are conſiderably larger than in the mammalia; and the ſubſtance of the lungs is not divided into lobuli. The cartilages of the trachea are loſt before that tube enters the lung; and ſome of its large branches open on the ſurface of the viſcous. I have obſerved in the oſtrich that this aperture was ſurrounded by circular muſcular fibres, which do not ſeem to have been hitherto noticed.

(B) Beſides the air-cells of the circumſcribed cavities, and of the bones, theſe cavities are formed in ſome inſtances in the ſoft parts. They often extend from the axillary cell under the pectoral muſcles, and thoſe of the ſcapula. "In the eagle, hawk, "ſtork, lark, and other high flying birds, theſe cells "are very large; and in many of thoſe birds there "are ſtill larger cells, aſcending under the integu-"ments of the neck, and paſſing beneath the ſkin of "the inſide of the arm, and back of the ſhoulder. "In the ſtork we found theſe cells large enough to "admit the finger to paſs a conſiderable way "down upon the inſide and back of the wing. "They are alſo large in the owl and other birds of "prey." Macartney in Rees's *Cyclopedia*, art. Birds.

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The whole of this ſubject is explained at great length, and with minute details in the above-quoted article.

(C) The amphibia are diſtinguiſhed in all inſtances by the great ſize of their air-veſicles. In the *frogs*, *lizards*, and *ſerpents*, the lung conſiſts of a cavity, the ſides of which are cellular. The lower or poſterior part of the organ either forms a mere membranous bag (the parietes of which are not cellular) or elſe the veſicles are larger at that part than elſewhere. In the ſerpents the lung has that elongated form, which characteriſes all the viſcera of theſe animals. A conſiderable portion of it is a ſimple membranous cavity; and this is ſupplied with arteries from the ſurrounding trunks. The *turtles* have a more complicated ſtructure; or one which approaches more nearly to that of the warm-blooded claſſes. The lungs are uniform in their texture throughout; but the veſicles are very large. The cartilaginous annuli of the bronchi terminate before theſe veſſels enter the lungs.

(D) *Fourcroy* found azotic with a ſmall proportion of carbonic acid gas in the carp: LACEPEDE met with hydrogen in the tench; and pure oxygen has been found in the ſhark. (DUNCAN's *Annals*, vol. 1, p. 393).

The air-bladder does not exiſt in many fiſhes; whence CUVIER argues with juſtice againſt the opinion which aſſigns this part an important office in reſpiration. Indeed it ſeems much more probable that it is ſubſervient to the motions of the animal. For it is largeſt in ſuch fiſhes, as ſwim with conſiderable velocity. It is wanting in the flat fiſhes; where the large lateral fins ſupply its place, and in the ſhark, where its abſence is compenſated by the ſize and ſtrength of the tail. It does not exiſt in the lamprey, which poſſeſſes none of theſe compenſations for its abſence: that fiſh therefore creeps ſlowly at the bottom of the water.

It is found in ſome ſpecies of *ſcomber;* while others want it: viz. the mackerel (*ſcomber ſcombrus*). Its form varies ad infinitum in the different genera and ſpecies. Its cavity is generally uniform: but ſometimes divided by ſepta, as in the *ſilurus;* and being even very cellular in the *diodon.*

Its ſides vary conſiderably in thickneſs; and are ſometimes bony, as in the *cobitis foſſilis.*

There is generally a vaſcular and glandular body ſituated in the cavity; which probably ſecretes the contained air. In the *perca labrax* are two bodies on the outſide of the bag; giving riſe to ſeveral veſſels, which contain air. Theſe unite together, and open into the cavity.

(E) In the terreſtrial gaſteropodous molluſca, of which we may inſtance the ſnail and ſlug, there is a cavity in the neck receiving air by a ſmall aperture, which can be opened or ſhut at the will of the animal. The pulmonary veſſels ramify on the ſides of the cavity.

CHAPTER XV.

ON THE ORGAN OF THE VOICE.

§ 193. ARISTOTLE has correctly obſerved, that thoſe animals only, which poſſeſs lungs, conſequently the three firſt claſſes of the animal kingdom, poſſeſs a true voice. Several genera and ſpecies even of theſe are either entirely dumb; as the *anteater*[1], the *mans*, the *cetacea*[2], the genus *teſtudo*, ſeveral *lizards* and *ſerpents;* or they loſe their voice in certain parts of the earth; as the *dog* in ſome countries of America, and *quails*[3] and *frogs*[4] in ſeveral parts of Siberia.

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[1] In a preparation—a dried one indeed—of the larynx and lungs of the two-toed anteater, I find the larynx entirely bony, that is, of the ſame ſubſtance with the os hyoides. The trachea, which is extremely ſhort, is a merely membranous canal, without any perceptible trace of cartilaginous rings.

[2] JNO. HUNTER found no thyroid gland in the whales, which he diſſected. This coincides with that hypotheſis, which conſiders this gland to be connected with the formation of the voice. (CUVIER however ſtates its exiſtence in the *dolphin* and *ſeal*, tom. 4. p. 523. T.)

[3] PENNANT's *Arctic Zoology*, tom. 2. p. 3 0.

[4] MULLER's *Collection of Ruſſian Diſcoveries*, vol. 7. p. 123. J. C BECKMANN's *Hiſtorical Deſcription of the Chur and Mark of Brandenburg*, vol. 1. p. 590.

(A) Mammalia.

§ 194. Moſt animals of this claſs[5] have the following circumſtances in common: their rima glottidis is provided with an epiglottis, which in moſt inſtances has a peculiar muſcle, ariſing from the os hyoides, and not found in the human ſubject: the margins of this rima are formed by the double ligamenta glottidis, *(ligamenta thyreo-arytænoidea)*; between which the ventriculi laryngis are formed. The epiglottis does not exiſt in moſt of the bat kind: and in ſome mouſe-like animals, as the rell-mouſe *(glis eſculentus)*, it is hardly diſcernible. The ſuperior ligamenta glottidis, as well as the ventriculi laryngis are wanting in ſome biſulca, as the ox and ſheep.

§ 195. Some ſpecies of mammalia have a peculiar and characteriſtic voice; or at leaſt certain tones, which are formed by additional organs. Of this kind are certain tenſe membranes in ſome animals; and in others peculiar cavities, opening into the larynx, and ſometimes appearing as continuations of the ventriculi laryngis.

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[5] Beſides the two old, and highly valuable works on the organ of the voice, by Casserius and Fab. ab Aquapendente; and the writings which we ſhall have occaſion to quote in the ſequel, I refer the reader to M. J. Busch *Diſſert. de Mechaniſmo Organi Vocis*. Groning. 1770, 4to. which contains ſeveral excellent obſervations by Camper.

The neighing of the horſe, for example, is effected by a delicate, and nearly falciform membrane, which is attached by its middle to the thyroid cartilage, and has its extremities running along the external margins of the rima glottidis[6].

The peculiar ſound, uttered by the aſs, is produced by means of a ſimilar membrane; under which there is an excavation in the thyroid cartilage. There are moreover two large membranous ſacs opening into the larynx[7].

The mule does not neigh like the mare, by which it was conceived; but brays like the aſs, which begot it. It poſſeſſes exactly the ſame larynx as the latter, without any of the peculiar vocal organs of the mother: a fact, which like many others, cannot be at all reconciled with the ſuppoſed preexiſtence of previouſly formed germs in the ovarium of the mother[8].

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[6] Herissant in the *Mem. de l'Acad. des Sc.* 1753. tab. 9.

[7] Ibid. tab. 10.

[8] I have adduced this eſſential, and really ſpecific difference in the ſtructure of the larynx of the horſe and aſs; as one of the many arguments, which overthrow that rule, adopted by Ray, Buffon, and others, of aſcribing to one and the ſame ſpecies, all ſuch animals, as produce by copulation an offspring capable of ſubſequent generation. See the 7th ed. of the *Manual of Natural Hiſtory*, p. 26.

The cat has two delicate membranes lying under the ligamenta glottidis; which probably cauſe the the purring noiſe peculiar to theſe animals [9].

The pig has two conſiderable membranous bags above and in front of the ligamenta glottidis [10].

Several apes [11] and baboons [12], as alſo the rein-deer [13], have on the front of the neck, large ſingle or double laryngeal ſacs, of various forms and diviſions, communicating with the larynx by one or two openings between the os hyoides and thyroid cartilage.

Some of the cercopitheci, as the *C. Seniculus*, and *beelzebub*, have the middle and anterior part of the os hyoides formed into a ſpherical bony cavity [14], by which the animals are enabled to produce thoſe terrific and penetrating tones, which can be heard at vaſt diſtances, and have gained them the name of the howling apes.

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[9] Vicq-d'Azyr in the *Mem. de l'Acad. des Sciences*, 1779, tab. 11. fig. 17.

[10] Casserius *de Vocis audituſque Organis*, tab. 10. fig. 9, 10. p. 55. " *ad grunnitum in porcis efficiendum.*" Herissant *loco citato*, tab. 11.

[11] As the orang utang. See Camper's Natural Hiſtory of that animal—the *Simia inuus* ſee Ludwig's *Natural Hiſtory of Man*. In a common ape (*ſimia ſylvanus*) I found the right laryngeal ſac three inches long, and two inches in circumference; while the left was not larger than a nutmeg. The larynx of the *ſimia cynomolgus* may be ſeen in the work above quoted of Camper.

[12] It is repreſented in the Mandril (*Papio Maimon*) by Vicq-d'Azyr loco citato, tab. 7.

[13] Camper loco citaco, tab. 8. fig. 7.

[14] Vicq-d'Azyr loc. cit. tab. 9. 10. Camper, tab. 4.

(B) Birds.

§ 196. The moſt ſtriking peculiarity in the vocal organs of this claſs, and which belongs to all birds with a very few exceptions; conſiſts in their poſſeſſing, what is commonly called, a *double larynx*, but which might be more properly deſcribed, as a larynx, divided into two parts, placed at the upper and lower ends of the trachea. They have alſo two rimæ glottidis.

§ 197. The ſuperior, or proper rima glottidis is placed at the upper end of the trachea; but is not furniſhed with an epiglottis[15]. The apparent want of this organ is compenſated in ſeveral caſes by the conical papillæ placed at both ſides of the rima.

§ 198. The apparatus, which is chiefly concerned in forming the voice of birds, is found in the inferior or bronchial larynx[16]. This contains a ſecond rima glottidis, formed by tenſe membranes; which may be compared in ſeveral caſes, particularly among the aquatic birds, to the reed at the mouth of muſical inſtruments. It is furniſhed externally with certain pairs of muſcles, varying in number in the different orders and genera; and with a kind of thyroid gland. The courſe and proportionate length of the trachea, and particularly the ſtructure of the inferior larynx, vary very conſiderably[17] in the different ſpecies, and even in the two ſexes, eſpecially among the aquatic birds. Thus, for example, the tame or dumb ſwan, *(anas olor)* has a ſtraight trachea; whilſt in the male of the wild or whiſtling ſwan *(cygnus)*, this tube makes a large convolution, which is contained in the hollow of the ſternum (ſee § 55). In the ſpoonbill *(Platalea leucorodia)* as alſo in the *Phaſianus motmot*, and others, ſimilar windings of the trachea are found, not encloſed in the ſternum. The males of the two genera *anas* and *mergus* have at their inferior or bronchial larynx a bony cavity,[18] which contributes to ſtrengthen their voice.[19] See note (A), at the end of the chapter.

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[15] The part which Warren has deſcribed in the 34th vol. of the *Philoſ. Tranſ.* p. 113. as the epiglottis of the oſtrich, is merely a ſlight elevation at the root of the tongue. See Cuvier in the *Ménagerie du Muſeum National d' Hiſtoire Naturelle.* no. 1. tab. 3.

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[16] Hence the diviſion of the trachea below the upper rima glottidis ſcarcely produces any change in the voice of ſeveral birds: as they can ſtill utter ſounds by means of the bronchial larynx. See DUVERNEY in the *Hiſt. de l'Acad. des Sciences.* tom. 2. p. 7. GIRARDI *in the Memoirs of the Italian Society,* tom. 2. pt. 2. p. 737. and CUVIER in the *Magazin Encyclopedique.* Arm. 1. tom. 2. p. 357.

[17] On the ſubject of the bronchial larynx, the reader may conſult HERISSANT, VICQ-d'AZYR and CUVIER in their works already quoted: alſo another diſſertation by the latter author in the 2nd vol. of the 4th year of the *Magazin Encyclopédique.* SCHNEIDER in the *Leipſig Magazine* for 1786 and 1787, and in his valuable *Commentary on the Works of* FREDERIC II. pp. 32. 211.

ALDROVANDI has deſcribed that of the wild ſwan. *Ornitholog.* tom. 3. p. 13.

That of the gooſe has been moſt excellently deſcribed by HALLER *de partium corp. humani fabricâ et functionibus,* tom. 7. p. 321, which may be compared with the beautiful delineations of HERISSANT, *loc. citat.* tab. 12.

(C) AMPHIBIA.

§ 199. The ſtructure of the vocal organs in this laſt claſs of animals, which poſſeſs a voice, is on the whole very ſimple; although it varies in ſeveral genera and ſpecies, and ſometimes in the two ſexes. See note (B).

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[18] Beſides HERISSANT and CUVIER, loc. citat. the reader may conſult ALDROVANDI *ornithol* tom. 3. p. 190. WILLOUGHBY *ornithol.* tab. 73. BLOCH in the *Tranſactions of a Society for Inquiries concerning Natural Hiſtory*, at Berlin, tom. 4. p. 579, tab. 16. and in his works, tom. 3. p. 372. tab. 7. LATHAM in the *Tranſactions of the Linnæan Society*, vol. 4. p. 90. tab. 9. 16.

[19] See FABRICIUS HILDANUS on the *Excellence of Anatomy*, p. 323.

§ 200. The trachea forms different convolutions in ſome of the teſtudines,[20] and of the crocodile kind. It is very ſhort in the frog; but longer in the male, than in the female: the rima glottidis is alſo larger in the former. Ligamenta glottidis exiſt in all the animals of this claſs[21].

§ 201. The males of ſome frogs are diſtinguiſhed by peculiar membranous bags. The tree frog *(rana arborea)* has a large ſac in its throat; and the green frog *(rana eſculenta)* has two conſiderable pouches in the cheeks, which it inflates at the time of copulation by two openings cloſe to the rima glottidis[22]. See note (C).

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[20] Blasii *Zootoomia*, Amſt. 1677, 8vo. tab. 17. fig. 5. The tortoiſes (at leaſt the *teſtudo Græca)* may be ſaid to have two tracheæ: for the ſhort common trunk divides at the third cervical vertebra into two long branches, which deſcend far into the cheſt before they enter the lung. Each of them makes a large latteral convolution, over which the two *aortæ abdominales* bend their courſe.

[21] Vicq-d'Azyr, loc. citat. tab. 13. fig. 45, 46. repreſents theſe fragments in the teſtudines; fig. 41, 42, 44. in frogs; fig. 47—52 in ſerpents.

The larynx of the rattleſnake is repreſented in Tyson's *Anatomy of a Rattleſnake. Philoſ. Tranſ.* vol. 13. no. 144. fig. 5.

Additional Notes to the Fifteenth Chapter.

(A) "A very little compariſon of the mechaniſm of wind muſical inſtruments, with the organs of the voice in birds, will ſhew how nearly they are allied to each other; and it may be obſerved, that the ſound produced by ſome of the larger birds is exactly ſimilar to the notes that proceed from a clarionet or hautboy in the hands of an untutored muſician. The inferior glottis exactly correſponds to the reed, and produces the tone or ſimple ſound. The ſuperior larynx gives it utterance, as the holes of the inſtrument; but the ſtrength and body of the note depend upon the extent and capacity of the trachea, and the hardneſs and elaſticity of its parts. The convolution and bony cells of the windpipe, therefore, may be compared with the turns of a French horn, and the diviſions of a baſſoon; and they produce the proper effects of theſe parts in the voices of thoſe birds, in which they are found." Rees's *Cyclopedia, art.* Birds.

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[22] See the German Collection of CAMPER's *ſmaller works*, vol. 1. pt. 1. p. 144. tab. 3. fig. 1—4.

(B) All the amphibia want the epiglottis.

(C) The *chordæ vocales* are very large and diſtinct in the frog.

THE

ANIMAL FUNCTIONS.

CHAPTER XVI.

ON THE BRAIN AND NERVOUS SYSTEM IN GENERAL.

§ 202. THIS claſs of functions which conſtitutes the leading character of animals, and has derived its name from that circumſtance, affords to our obſervation a more clear and manifeſt gradation, from the moſt ſimple to the moſt compound ſtructure, than any others in the animal economy [1].

§ 203. In ſome of the moſt ſimple animals of the claſs *vermes*, particularly among what are called *Zoophytes*, little or no diſtinction of ſimilar parts [2] (or ſtructures) can be diſcerned; and we are unable to recognize any thing as a particular nervous

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[1] On the ſubject of this claſs of functions, the reader ſhould conſult the two firſt volumes of that maſterly work, the *Lectures on comparative Anatomy* of PROFESSOR CUVIER; which have been tranſlated into German, by PROFESSOR FISCHER.

[2] By the term *partes ſimilares*, the antients denoted thoſe homogeneous organic ſtructures, which form nerves, muſcles, tendons, bones, cartilages, &c.; the combination of which conſtitutes the *partes diſſimilares* of the animal body; i. e. the limbs, viſcera, &c.

ſyſtem,

ſyſtem, or even as a part of ſuch a ſyſtem. The power of ſenſation and voluntary motion, which theſe poſſeſs, as well as any other order or claſs of the animal kingdom, proves that the nervous matter muſt be uniformly ſpread throughout their homogeneous ſubſtance. The almoſt tranſparent polypes *(hydra)*, which are often found in this country, with a body of an inch in length, and arms or tentacula, of a proportionate ſize, appear to conſiſt, when ſurveyed in the beſt light by the ſtrongeſt magnifying powers, of nothing but a granular ſtructure (ſomething ſimilar to boiled Sago) connected into a definite form by a gelatinous ſubſtance.

§ 204. In many other vermes, and in inſects, particular nerves can be diſtinguiſhed, ariſing in general from what is called the ſpinal marrow, the ſuperior extremity of which part, ſlightly enlarged, conſtitutes the brain. The latter organ, however, in both claſſes of cold and red-blooded animals, and ſtill more in thoſe which have warm blood, has a much more complicated ſtructure, and a far greater relative magnitude: all animals are however exceeded in both theſe points by the human ſubject, which, according to the ingenious obſervation of the learned SÖMMERRING[3], poſſeſſes by far the largeſt brain in proportion to the ſize of the nerves which ariſe from it.[4] (See note (A) at the end of the chapter.)

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[3] See his *Diſſertatio de baſi Encephali*, Goetting. 1778. p. 17. and his *Tabula baſeos Encephali*, Francof. 1799, p. 5. Alſo J. G.

(A) MAMMALIA.

§ 205. The two large proceſſes of the dura mater, which form the falx and tentorium, poſſeſs a very peculiar ſtructure in ſome animals of this claſs. A ſtrong plate of bone, which is a proceſs of the neighbouring bones of the cranium, is contained between their two laminæ.

We have hitherto aſcertained only one example of ſuch a formation of the falx, in the quadrupeds

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J. G. Ebel, *Obſerv. Neurol. ex Anatome comparat.* Francof. ad Viadrum, 1788-8.

[4] The ſmall ſize of the brain in proportion to the reſt of the nervous ſyſtem has a very conſiderable influence on the whole animal economy of cold-blooded, when viewed in compariſon with warm-blooded animals. It explains the diminiſhed ſympathy between the two parts; and the conſequently weak powers of motion of their whole machine. It enables us alſo to underſtand the remarkable independence of the vitality of their parts upon that of the brain; and their poſſeſſion of conſiderable individual powers of life: as alſo the extraordinary extent of their reproductive powers. I have treated at greater length on all theſe points in my *Specimen Phyſiologiæ comparatæ inter Animentia calidi et frigidi Sanguinis*, in the 4th vol. of the Goettingen Commentaries; and in the *Manual of Natural Hiſtory*, p. 225. of the 7th edition. (See note (B) at the end of the chapter.)

of this claſs: and this I diſcovered in the *ornithorhynchus*, an animal which abounds in inſtances of anomalous ſtructure. Something ſimilar is found in the cetacea, at leaſt in the porpoiſe[5]. The falx itſelf deſcends to various depths between the hemiſpheres in the different ſpecies[6].

A bony tentorium cerebelli is found in a great number of mammalia: but its ſize and extent vary in the different ſpecies. It is formed by peculiar oſſeous plates, extending from the vitreous table of the parietal bones, and the petrous portions of the oſſa temporum. Its formation exhibits two kinds of variety.

In ſome animals, for inſtance, it conſtitutes an uniform bony partition, which leaves a quadrangular opening into the lower part of the cranium. This is the caſe in moſt ſpecies of the cat and bear kind; in the martin *(muſtela martes)*; in the coaita *(cercopithecus paniſcus)*[7] and others.

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[5] A ſimilar ſtructure, conſtituting an unique ſpecimen of anatomical variety, is exhibited in the ſkull of a female, belonging to my collection. The vitreous table of the frontal bone has a long falciform bony criſta, at the attachment of the falx.

[6] See on this ſubject SÖMMERRING, *on the Brain and Spinal Marrow*, in German. Mentz, 1788-8. A work, which is extremely valuable for its comparative anatomy.

[7] JOSEPHI's *Anatomy of Mammalia*, in German. *Contributions to the firſt vol.* p. 34. tab. 4.

It conſiſts of three ſeparate portions in other animals, one of theſe pieces projects from the upper and back part of the cranium, like a tile; the two lateral portions ariſe from the petrous part of the temporal bone. This ſtructure is exemplified in the ſeal[8], dog, and horſe.

In ſome caſes, as in the pig, the rabbit, ſome mice, &c. a rudiment of the laſt mentioned lateral portions may be obſerved; or at leaſt the ridge of the temporal bone is much ſharper than uſual[9].

§ 206. The peculiarities, which diſtinguiſh the brain of the human ſubject from that of the mammalia[10], conſiſt chiefly in the circumſtance, which has been already noticed, of its poſſeſſing a much greater bulk in proportion to the nerves, which ariſe from it; and in its being much larger when compared with the cerebellum, and medulla ſpinalis [11]. (See note (D) at the end of the chapter.)

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[8] In the cranium of a young ſeal, which I poſſeſs, the anterior or upper ſurface of the tile-ſhaped piece is connected by means of a ſtrong perpendicular bony plate; extending to the middle of the lambdoid ſuture, with the inner ſurface of the occipital bone, where the falx terminates.

[9] I have already deſcribed the chief varieties of the bony tentorium, and have mentioned the uſes aſſigned to this ſtructure, which appear however improbable, in the deſcription of the bones, p. 117; and in the Inſtitut. Phyſiol. p. 160, ed. of 1798. (See note (C) at the end of the chapter.)

[10] The reader may conſult the following delineations of the brain of mammalia, beſides thoſe which will be referred to in ſubſequent notes. Of the chimpanſé *(ſimia troglodytes)* by TYSON in his excellent "*Anatomy of a Pigmy*," fig. 13, 14. Of the dog, by COLLINS, *Syſtem of Anatomy*, vol. 2. tab.

§ 207. Moreover, that remarkable and enigmatical collection of ſandy matter, which is found in the pineal gland [12] of the human brain, almoſt invariably after the firſt few years of exiſtence, has been hitherto obſerved in a very few other mammalia, and thoſe among the *biſulca* [13].

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53. fig. 1; and Ebel, *loc. cit.* tab. 1, fig. 7. Of the cat, by Collins, tab. 53, fig. 2; and Ebel, tab. 1, fig. 3. Of the horſe, by Vicq-d'Azyr, *Mem. de l'Acad. des Sciences*, 1783, tab. 7; Ebel, tab. 1, fig. 1. Of the ſheep, by Vicq d'Azyr, tab. 8, fig. 1; and Ebel, tab. 1, fig. 8. Of the ox, Vicq-d'Azyr, tab. 8, fig. 2; Ebel, tab. 1, fig. 6 and 9. Of the pig, Collins, tab. 54; Ebel, tab. 1, fig. 10.

[11] The delineation, which I have given of the brain of the mandrill *(Papio Maimon,)* in the two firſt editions of my work, *de Generis Humani Varietate Nativâ.* tab. 1, fig. 1, ſhews how ſtriking this difference is, even in the *quadrumana*, which from their great general reſemblance to the human ſubject have been called *Anthropomorpha*.

[12] Sömmerring *de lapillis, vel prope, vel intra Glandulam pinealem ſitis.* Mentz, 1785. 8vo.

[13] Sömmerring has found it in the fallow-deer *(cervus dama)*: ſee his *Diſſ.* p. 10. And Malacarne in the goat: "*Diſſection of the Brain of ſome Quadrupeds*:" in Italian, Mant. 1795 4. p. 31.

§ 208.

§ 208. In the proper quadrupeds (the *quadrumana* therefore being excepted), the anterior lobes of the brain form two large proceſſes *(proceſſus mamillares)*[14], from which the olfactory nerves of the firſt pair proceed. Theſe are of very conſiderable magnitude, particularly in the herbivorous animals[15]. They contain a continuation of the lateral ventricle; which circumſtance has formerly given riſe to great phyſiological errors[16].

§ 209. The ſtructure of the *corpora quadrigemina*, and *candicantia* diſtinguiſhes the brain of herbivorous from that of carnivorous quadrupeds. The *nates* very conſiderably exceed the *teſtes* in ſize, in the former claſs while theſe proportions are reverſed in the latter inſtance. The herbivora have a ſingle large *eminentia candicans*: there are two ſmall ones in the carnivora[17]. (See note (E) at the end of the chapter.)

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[14] See METZGER *Specimen Anatomiæ comparatæ primi paris Nervorum*, in his *Opuſc Anat. and Phyſiol.* Göthing. 1790, 8vo. p. 100.

[15] This part is repreſented in the biſulca, and in the hare-kind in COLLINS's *Syſtem of Anatomy*, vol. 2, tab. 51. EBEL *loc. cit.* WILLIS *Anatome Cerebri*, fig. 2. MONRO *on the Nervous Syſtem*, tab. 9 and 24.

[16] Theſe were firſt refuted by that excellent anatomiſt C. V. SCHNEIDER of Wittenberg. See his claſſical work *de Oſſe Cribriformi*, 1655. 12mo.

[17] SÖMMERRING *on the Brain*, &c. p. 91.

(B) BIRDS.

(B) Birds.

§ 210. The dura mater forms, in ſome birds, a falciform proceſs; which has been erroneouſly aſſerted to be deficient in the whole claſs[18]. In the cock of the woods *(tetrao urogallus)*[19] it has a bony ſtructure, reſembling that of the *ornithorhynchus*.

§ 211. The brain itſelf, conſidered altogether, reſembles that of the former claſs (even in forming in ſome inſtances a kind of *proceſſus mamillares)*, while, on the contrary, it is ſtrikingly diſtinguiſhed from that of the following order. It differs, however, from that of the mammalia, not only in the ſmoothneſs of its ſurface, and the want of convolutions, but alſo in the ſtructure of the optic thalami. Theſe eminences, which are nearly ſpherical, and hollow internally, are not contained in the proper brain or cerebrum, but lie behind and below that part. This ſtructure is common to birds with the two claſſes of cold and red-blooded animals. Thoſe eminences alſo, which in the mammalia are juſtly termed *corpora ſtriata*, are of an uniform colour in birds. (See note (F) at the end of the chapter.)

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[18] This miſtake has even been committed by Haller *de Partium Corp. Hum. Fabricâ and Functionibus*, tom. 8, p. 163.

[19] The brain of this bird is remarkably ſmall in proportion to the ſize of its head and whole body; while we know, that in ſome other animals of this claſs, particularly among the ſinging-birds, the brain exceeds that of the human ſubject in theſe points of view.

§ 212. The brain of birds does not poſſeſs ſeveral parts, which are found in that of the mammalia; and the opinions of anatomiſts are much divided concerning others, on account of variations in their ſtructure and appearance. The corpus calloſum, pons varolii, &c. come under the deſcription of parts, which are certainly absent. The exiſtence of the fornix, pineal gland, corpora candicantia, and quadrigemina, is a matter of diſpute[20].

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[20] See Haller's valuable obſervations *de cerebro avium*, in the *Opera Minora*, vol. 3. And Malacarne's long commentary on them in the three firſt volumes of the *Memoirs of the Italian Society*.

Several authors have given repreſentations of the brain of birds. That of the gooſehawk, the owl, the finches (*Fringillæ*), the pigeon, the partridge, and the gooſe has been delineated by Ebel, *loc. citat.*

That of the kingsfiſher, the red bird (*loxia cardinalis*), the turkey, the buſtard, the woodcock, ſnipe, and others of the genus *ſcolopax*, the ſwan, gooſe, and duck, by Collins, loc. citat. tab. 49, 56, 57, and 58.

That of the raven and common cock by Vicq-d'Azyr, in the *Mémoires de l'Acad. des Sciences*, 1783, tab. 9 and 10.

That of the gooſe in a lateral and internal view, by Ludwig, de *Cinereâ Cerebri Subſtantiâ*, Lipſ. 1779, 4to. fig. 1.

(C) AMPHIBIA.

§ 213. Anatomiſts have hitherto beſtowed but little labour, comparatively ſpeaking, on the brain of amphibia. It is ſmall and ſimple, and conſiſts of five roundiſh eminences: viz. the two hemiſpheres, the two thalami nervorum opticorum, lying behind theſe, and ſeparate from them, and excavated by a ventricle; and the cerebellum, which in both claſſes of cold red-blooded animals contains no arbor vitæ. The ſpinal marrow, compared with the brain, is of aſtoniſhing magnitude in moſt amphibia[1]. (See note (G) at the end of the chapter.)

(D) FISHES.

§ 214. In this claſs of animals the brain does not fill the cranium. Between the pia and dura mater (which in moſt of the large fiſhes approaches to a cartilaginous firmneſs) there is collected a ſalt and greaſy fluid, contained in a looſe cellular texture, which ſeems to ſupply the place of the tunica arachnoidea[2].

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[1] The brain of the tortoiſe has been delineated by CALDESI in his *Obſervations*, &c. tab. 2, fig. 5. That of the frog by LUDWIG, VICQ-D'AZYR, and EBEL, *locis citatis*: and that of the viper by VICQ-D'AZYR, tab. 10, fig. 8.

[2] CASSERIUS has given an excellent view of the cranium of a pike laid open, *de Auditu*, tab. 12.

§ 215. The ſtructure of the brain varies in the different genera and ſpecies; ſometimes even in the individuals of the ſame ſpecies. It conſiſts of ſeveral tubercles or lobuli diſpoſed in pairs; and of theſe, the five, which were deſcribed in the brain of the amphibia, are the moſt conſtant[3].

§ 216. In moſt fiſhes the optic nerves decuſſate, (juſt like two fingers laid croſſwiſe); a remarkable peculiarity which has given riſe to ſeveral phyſiological inveſtigations, and inferences[4]. (See note (H) at the end of the chapter.)

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[3] Haller *de Cerebro Piſcium* in the *Opera Minora*, tom 3, p. 198. Collins has given repreſentations of the brain in almoſt all the orders of fiſhes; but his views are chiefly of the upper external ſurface, tab. 60 to 70. That of the *ſkate* is delineated in the 2nd vol. of Camper's *ſmaller writings*, tab. 3: by Monro in his *Phyſiology of Fiſhes*, tab. 1, 34 and 37; and by Scarpa *de Auditu et Olfactu*, tab. 1, fig. 1. That of the ſhark, by Stenonis *Elementa Myolog.* tab. 5 and 7. and by Scarpa, *loc. cit.* tab. 2. That of the frog-fiſh (*lophius piſcatorius*) by Camper, *loc. citat.* tab. 1.

That of the conger-eel, turbot, and pike, by Vicq-d'Azyr, *loc. citat.* tab. 10. That of the cod, by Camper, *loc. citat.* and Monro. That of the haddoc, by Monro, *on the Nervous Syſtem*, tab. 32. That of the ſilurus, by Ebel, *loc. cit.* tab. 2, fig. 4. That of the pike by Casserius, Ebel, and Scarpa, *locis citatis*. That of the carp by Ebel and Scarpa.

[4] See Sömmerring in the *Heſſian Literary Contributions*, vol. 1, pt. 2, p. 205. alſo his *Diſſert. de Decuſſatione Nervor. Opticor.*

Theſe nerves have in ſome fiſhes the uncommon ſtructure of an inveſtment of pia mater containing very elegant longitudinal folds[5].

The olfactory nerve ſometimes forms a ganglion juſt before it is diſtributed to the noſe. The *gadus merluccius* and the carp[6] afford examples of this ſtructure, which is remarkable inaſmuch as no ganglia have been hitherto obſerved in the nervous ſyſtem of fiſhes.

§ 217. We muſt laſtly mention thoſe nerves, which are diſtributed, in the electrical fiſhes, to that wonderful apparatus of membranous cells, filled with a gelatinous ſubſtance like white of egg, and performing the office of a Leyden jar, or electrical battery. Theſe curious organs occupy the

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Opticor. Mogunt. 1786, p. 24. COOPMAN's *Neurolog.* p. 38. Profeſſor RUDOLPHI in WIEDEMANN's *Archives*, vol. 1, pt. 2, p. 156, and ſeveral of the delineations quoted in the preceding note.

[5] See EUSTACHII *Oſſium Examen*, p. 227, and a repreſentation from the ſaw-fiſh (*ſqualus priſtis*) in MALPIGHI *de Cerebro*. In order to compare this, with the ordinary ſtructure of other nerves, ſee the repreſentation of the phyſiological preparation of the commencement of the fifth pair in the elephant, in A. K. BOERHAVE, *Hiſtoria Anatomica* (*prior*) *infantis, cujus pars Corporis inferior Monstroſa*. Peterſburg, 1754, 4to. tab. 1.

[6] SCARPA, *loco citato*.

lateral fins of the torpedo[7], and receive their nervous ſupply from the fifth pair. In the electrical eel *(gymnotus)*, the electrical organ is found towards the poſterior part of the abdomen[8], and its nerves come from the medulla ſpinalis. In the *ſilurus electricus*, it is placed between the ſkin and muſcles over the whole body, and its nerves are derived from the eighth pair[9].

(E) INSECTS.

§ 218. The general ſtructure of the nervous ſyſtem in this claſs has been already mentioned (§ 204).

The larvæ, in which the ſubject has been moſt completely inveſtigated[10], have a brain conſiſting of two ganglia, contained in a horny cavity larger than itſelf. The nervous cord, which in red-blooded animals conſtitutes the medulla ſpinalis, proceeds from this point along the abdomen, forming in its paſſage twelve ſimple ganglia, from which, and from the two ganglia forming the brain, the nerves derive their origin [11].

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[7] HUNTER in the *Philoſ. Tranſ.* vol. 63, p. 481, tab. 20; and GIRARDI in the *Memoirs of the Italian Society*, tom. 3, p. 553.

[8] HUNTER in the *Philoſ. Tranſ.* vol. 65, p. 395, tab. 9.

[9] GEOFFROY in the *Bulletin de la Societé Philomatique*, 6 annee, tom. 3, p. 169.

[10] See LYONET's excellent account of the larva of the *Phalæna Coſſus*, tab. 9, 10, and 18. That of the ſilkworm by SWAMMERDAM, tab. 28, fig. 3. (which is better than MALPIGHI's repreſentation); and by BIBIENA in the *Comment. Inſtit. Bonon.* tom. 5, pt. 1, tab. 4. That of the butterfly, by BIBIENA, ibid.

(F) VERMES.

§ 219. Excepting thoſe animals, which inhabit corals, and the proper zoophytes, moſt genera of the other orders of this claſs are found to poſſeſs a diſtinct nervous ſyſtem [12]: although former anato-

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[11] The nervous ſyſtem of the larva of the ſtag-beetle, may be ſeen in SWAMMERDAM, tab. 28, fig. 1; and in RÖESEL, tom. 2, tab. 8. That of the *ephemera,* in SWAMMERDAM, tab. 14, fig. 1, tab. 15, fig. 6. That of the male bee, ibid. tab. 22, fig. 6. That of the *muſca chamæleon,* in the different ſtages of its metamorphoſis, ibid. tab. 40, fig. 5, tab. 41, fig. 7. That of the larva of the *muſca putris,* ibid. tab. 43, fig. 7. That of the louse, tab. 2, fig. 7. That of the lobſter, WILLIS *de Animâ Brutorum*, tab. 3, fig. 1.

HUMBOLDT'S *Experiments on the Irritation of Muſcular and Nervous Fibres*, in German, vol. 1, contain ſeveral excellent anatomical and phyſiological remarks on the nervous ſyſtem of ſome inſects, p. 273, 286.

[12] See JOS. MANGILI *de Syſtemate Nerveo Hirudinis, Lumbrici Terreſtris, aliorumque Vermium.* Ticini, 1795. A German verſion of this work is given in the 2nd vol. of REIL'S *Phyſiological Archives.*

The nervous ſyſtem of the leech has been ſhewn by REDI *de Viventibus intra Viventia*, tab. 14, fig. 9; and BIBIENA *Comment. Inſtit. Bonon.* tom. 7, tab. 2, fig. 5, tab. 3, fig. 6. BENING'S anatomiſts have expreſsly declared in ſeveral inſtances that no ſuch parts exiſted [13]. The ſtructure and diſtribution of the nerves poſſeſs in many caſes a ſurpriſing analogy to thoſe of inſects. The nervous ſyſtem of the ſea-mouſe *(aphrodite aculeata)*, for example, is very ſimilar to that of the larvæ [14]. In others, it is more anomalous: thus, in the cuttle-fiſh, two large nervous chords ariſe from the brain, and form in the breaſt two club-ſhaped ganglia; from which numerous nerves proceed [15]. (See note (I).

Additions to the Sixteenth Chapter.

(A) As the works in which this moſt important phyſiological poſition is confirmed and eluci-

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NING's excellent work on the leech, and MANGILI's book may alſo be conſulted.

The nerves of the ſlug are repreſented by SWAMMERDAM, tab. 9, fig. 2. and thoſe of the *helix pomatia*, ibid. tab. 4, fig. 6; tab. 6, fig. 1; which may be compared with the drawing by SPALLANZANI, in the *Memoirs of the Italian Society*, tom. 2, pt. 2, p. 545.

[13] See the remarks of HUMBOLDT in his work above quoted, p. 259, and CUVIER's claſſical work, which I here quote once for all, tom. 2, p. 298.

[14] PALLAS, *Miſcellanea Zoologica*, tab. 7, fig. 13.

[15] SWAMMERDAM, tab. 52, fig. 2. MONRO *on the Phyſiology of Fiſhes*, tab. 41, fig. 3. SCARPA, *loc citat.* tab. 4, fig. 7. TILESIUS in ISENFLAMM and ROSENMULLER's *Contributions to Anatomy*, in German, vol. 1, pt. 2, tab. 2.

dated, are not very generally known in this country, I ſhall take the liberty of explaining it in a ſomewhat more detailed form.

The vaſt ſuperiority of man over all other animals in the faculties of the mind, which may be truly conſidered as a generic diſtinction of the human ſubject, led phyſiologiſts at a very early period to ſeek for ſome correſponding difference in the brains of man and animals. They naturally inveſtigated the ſubject in the firſt inſtance, by comparing the proportion, which the maſs of the brain bears to the whole body: and the reſult of this compariſon in the more common and domeſtic animals was ſo ſatisfactory that they proſecuted the inquiry no further, but laid down the general propoſition, which has been univerſally received ſince the time of ARISTOTLE, that man has the largeſt brain in proportion to his body. Some more modern phyſiologiſts however, in following up this comparative view in a greater number of animals, diſcovered ſeveral exceptions to the general poſition. They found that the proportion of the brain to the body in ſome birds exceeds that of man; and that ſeveral mammalia (ſome quadrumana, and ſome animals of the mouſe kind) equal the human ſubject in this reſpect.

As theſe latter obſervations entirely overturned the concluſion, which had been before generally admitted, SÖMMERRING has furniſhed us with another point of compariſon, that has hitherto held good in every inſtance: viz. that of the ratio, which the maſs of the brain bears to the nerves ariſing from it.

Let us divide the brain into two parts; that which is immediately connected with the ſenſorial extremities of the nerves; which receives their impreſſions, and is therefore devoted to the purpoſes of animal exiſtence. The ſecond diviſion will include the reſt of the brain, which may be conſidered as connecting the functions of the nerves, with the faculties of the mind. In proportion then as any animal poſſeſſes a larger ſhare of the latter, and more noble part; that is, in proportion as the organ of reflexion exceeds that of the external ſenſes; may we expect to find the powers of the mind more vigorous and more clearly developed. In this point of view man is decidedly pre-eminent: here he excels all other animals that have hitherto been inveſtigated.

All the ſimiæ, ſays SÖMMERRING, are placed far behind man in this reſpect. Although the brain in ſome inſtances, particularly among the ſmaller kinds, which have prehenſile tails, is larger in proportion to their body than that of the human ſubject; yet a very large ſhare of that brain is required for the immenſe nerves, which ſupply their organs of ſenſe and maſtication. Let us remove that portion of the brain, and a very ſmall quantity will remain.

The reſearches of the ſame author on animals in general have led him to conclude, that the quantity of brain, over and above that which is neceſſary for a mere animal exiſtence—that part, in ſhort, which is devoted to the faculties of the mind, bears a direct ratio, to the docility of the animal; to the rank which it would hold in a comparative ſcale of mental powers.

The largeſt brain, which SÖMMERRING has found in a horſe, weighed ℔i. 4 oz. and the ſmalleſt, which he has ſeen in an adult man, was ℔ij. 5½ oz. Yet the nerves ariſing from the former brain were at leaſt ten times larger than thoſe of the latter.

Generally ſpeaking ſmall animals have a larger brain in proportion to their body than larger ones. The pachydermata have it very ſmall; and in red-blooded animals, its ſize is very trifling when compared with the body.

It forms in man from $\frac{1}{22}$ to $\frac{1}{35}$ of the body.

In ſome ſimiæ -	$\frac{1}{22}$
the Mole -	$\frac{1}{36}$
Bear -	$\frac{1}{265}$
Dog -	$\frac{1}{161}$
Cat -	$\frac{1}{94}$
Hare -	$\frac{1}{228}$
Rat -	$\frac{1}{76}$
Mouſe -	$\frac{1}{43}$
Elephant -	$\frac{1}{500}$
Pig -	$\frac{1}{412}$ — $\frac{1}{672}$

In

In the Horse	$\frac{1}{400}$
Dolphin	$\frac{1}{5}$ — $\frac{1}{102}$
Eagle	$\frac{1}{260}$
Sparrow	$\frac{1}{25}$
Chaffinch	$\frac{1}{27}$
Redbreaſt	$\frac{1}{32}$
Blackbird	$\frac{1}{68}$
Canary-bird	$\frac{1}{14}$
Cock	$\frac{1}{25}$
Duck	$\frac{1}{257}$
Gooſe	$\frac{1}{360}$
Tortoiſe	$\frac{1}{2240}$
Turtle	$\frac{1}{5688}$
Coluber natrix	$\frac{1}{792}$
Frog	$\frac{1}{172}$
Shark	$\frac{1}{2496}$
Pike	$\frac{1}{1305}$
Carp	$\frac{1}{560}$

(B) The following is the paſſage to which the author refers in his “ *Manual of Natural Hiſtory*”. “ The extraordinary ſtrength of the reproductive power in ſeveral amphibia, (ſee note (G) to § 136) and the aſtoniſhing facility, with which the proceſs is carried on, muſt be explained, if I miſtake not, from the great magnitude of their nerves, and the diminutive proportion of their brain. The former parts are in conſequence leſs dependent on the latter; hence the whole machine has leſs powers of motion, and diſplays leſs ſympathy: the mode of exiſtence is more ſimple, and approaches more nearly to that of the vegetable world, than in the warm-blooded claſſes:—but, on the contrary, the parts poſſeſs a greater individual independent vitality. Since, in conſequence of this latter endowment, ſtimuli, which operate on one part, or one ſyſtem, do not immediately affect the whole frame by ſympathy, as in warm-blooded animals; we are enabled to explain the peculiar tenacity of life, which is diſplayed under various circumſtances in this claſs; viz. frogs ſtill continue to jump about after their heart has been torn out; and turtles have lived for months after the removal of the whole brain from the cranium. The long continued power of motion in parts, which have been cut off from the body, as in the tail of the water-newt, and blind-worm, may be explained upon the ſame principles". Edit. 6th, § 98, p. 221.

(C) " It is difficult, (ſays the author in his *deſcription of the bones*) to give a phyſiological explanation of the uſe of this bony tentorium. The opinion, which has been generally adopted by anatomiſts, that the ſtructure in queſtion belongs to ſuch animals only, as jump far, or run with great velocity, and that it ſerves the purpoſe of protecting the cerebellum from the preſſure of the cerebrum in theſe quick motions, is obviouſly unſatisfactory. It exiſts in the bear, which is not diſtinguiſhed for its activity: while ſeveral animals, which excel in jumping or ſpringing, do not poſſeſs it; viz. the wild goat, (*capra ibex*), in which I could not diſcover the leaſt trace of ſuch a ſtructure. CHESELDEN aſcribes it to predacious animals only (*Anat. of the Bones*, cap. 8); but I have already enumerated ſeveral others. It may perhaps obviate the concuſſion, which would ariſe from ſtrong exertions in biting; for ſuch exertions are made in all the animals, which poſſeſs this ſtructure; even by the horſe in his wild ſtate." p. 118.

I have quoted theſe remarks on the generally aſſigned uſe of the bony tentorium, becauſe a ſemilar mechanical explanation has been given, of the falx and the tentorium of the human ſubject; viz. that the former protects the hemiſpheres from mutual preſſure when the perſon lies with his head reſting on one ſide; and that the latter provides againſt the compreſſion of the cerebellum by the ſuperincumbent cerebrum. Theſe explanations are aſſigned in the preſent day by anatomiſts of ſuch diſtinguiſhed reputation as SÖMMERRING and CUVIER (*de Corporis Humani Fabricâ*, vol. 4, p. 27. *Léçons d'Anat. compar.* tom. 2, p. 175). If the futility of this piece of phyſiology were not ſufficiently proved by conſidering that the cranium is accurately filled, and that there is conſequently no room for its contents to fall from one ſide to the other; it muſt immediately be rendered manifeſt by Mr. CARLISLE's caſe; in which the falx was entirely abſent, and the two hemiſpheres united throughout in one maſs, without any perceptible inconvenience during the patient's life. (*Tranſactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. 2, p 21[illegible]). I have met with four inſtances, in which the anterior half of the falx was deficient. This production of the dura mater commenced in a narrow form about the middle of the ſagittal ſuture; and gradually expanding, had acquired the uſual breadth at its termination in the tentorium. The two hemiſpheres adhered by the pia mater covering their oppoſed plane ſurfaces; but were formed naturally in other reſpects. A want of the falx has alſo been recorded by GARENGEOT (*Splanchnologie*, tom. 2, p. 24.)

(D) The proportion of the weight of the cerebrum, to that of the cerebellum, is generally, although not univerſally, greater in the human ſubject than in mammalia, as will appear from the following inſtances taken from the ſecond vol. of CUVIER. In the human ſubject the cerebellum is to the cerebrum, as - 1 to 9

In the *ſimia ſciurea* (ſquirrel-monkey) 1 — 14

Other-

Other ſimiæ	1 to 6, 7 or 8
Dog	1 to 8
Cat	1 — 6
Beaver	1 — 3
Mouſe	1 — 2
Hare	1 — 6
Boar	1 — 7
Cow	1 — 9
Sheep	1 — 5
Horſe	1 — 7

The proportion of the cerebrum to the medulla oblongata, as aſcertained by a compariſon of their diameters, exhibits a more conſtant ſuperiority in the human ſubject over the other mammalia, than the ratio of the Verebrum to the cerebellum.

In man the breadth of the medulla oblongata, after the pons varolii, is to that of the brain,

as	1 to 7
Simiæ	1 to 4 or 5
Dog	6 to 1
Cat	8 — 22
Rabbit	3 — 8
Pig	5 — 7
Deer	2 — 5
Cow	5 — 13
Horſe	8 — 21

Yet the dolphin forms a remarkable and ſingle exception to the general rule on this ſubject; for in that animal the proportions are as 1 to 13. In birds they are rather more than one to three.

(E) With the exception of man, and the ſimiæ, the mammalia cannot be ſaid to have poſterior lobes of the brain. The cerebellum is ſeen behind the cerebrum. The conſequence of this is, that the digital cavity or prolongation of the lateral ventricle into the poſterior lobe, is wanting.

The convolutions of the cerebrum do not exiſt in the rodentia. The ſimiæ only have an olfactory nerve, ariſing, like that of man, in a diſtinct chord from the brain. Other mammalia have a large cortical eminence *(proceſſus mamillaris)* filling the ethmoidal foſſa. As the cetacea have no organ of ſmelling, their brain has neither olfactory nerve, nor mamillary proceſs.

(F) Cuvier repreſents the brain of birds to conſiſts of ſix tubercles viſible exteriorly: viz. the two hemiſpheres, the optic thalami, a cerebellum, and medulla oblongata.

(G) The dura mater forms no proceſſes in the amphibia, nor in the fiſhes.

(H) In the ſkate, the right nerve goes through a fiſſure in the left; in bony fiſhes the decuſſation is more manifeſt, as one nerve merely lies on the other without any intermixture of ſubſtance. The fact has been noticed by COLLINS, WILLIS, and ſeveral others: it is repreſented by EBEL in the pike, carp, and *Silurus* glanis (*Obſ. Neurol. ex Anat. comp.* tab. 2, fig. 2, 3, and 4: this diſſertation is contained in the 3d vol. of LUDWIG's *Scriptores Neurol. Minores*). It does not ſeem to have been much inveſtigated in birds and the amphibia. In eight inſtances, where the eye of an animal had been deſtroyed or injured, the optic nerve was found to be altered in ſtructure and appearance as far as the union: and beyond that point the alteration extended along the oppoſite nerve to the oppoſite thalamus. (See EBEL loc. cit. tab. 1. fig. 1, and 2.) A ſimilar appearance has been found in a man. SÖMMERRING *de Decuſſat. Nerv. Optic.* in LUDWIG's Collection, tom. 1.

(I) In the claſs of inſects, and of vermes, the upper ganglion of the nervous chord, which repreſents the brain, is uſually placed near the mouth or œſophagus: which tube is ſurrounded by a nervous chord proceeding from that ganglion.

CHAPTER XVII.

ON THE ORGANS OF THE SENSES IN GENERAL, AND ON THAT OF THE SENSE OF TOUCH IN PARTICULAR.

§ 220. FEW ſubjects in comparative anatomy and phyſiology have given riſe to more various and contradictory opinions, than the organs of ſenſe in ſome claſſes of animals[1]. Much miſunderſtanding on this point has clearly ariſen from the inconſiderate and unconditional application of inferences, drawn from the human ſubject, to animals[2]. Thus it has been ſuppoſed that thoſe, which poſſeſs a tongue, muſt have it for the purpoſe of taſting; and that the ſenſe of ſmell muſt be wanting, where we are unable to aſcertain the exiſtence of a noſe. Obſervation and reflection will ſoon convince us, that the tongue, in many caſes (in the ant-eaters among the mammalia, and almoſt univerſally in birds), cannot from its ſubſtance and mechaniſm be conſidered as an organ of taſte; but muſt be merely ſubſervient to the ingeſtion and deglutition of the food. Again in ſeveral animals, particularly among inſects, an acute ſenſe of ſmell ſeems to exiſt, although no part can be pointed out in the head, which analogy would juſtify us in deſcribing as a noſe.

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[1] Much uſeful information on the organs of ſenſe, and indeed on comparative phyſiology in general, may be found in P. BODDAERTS' *Natuurkundige Beſchonwing der Dieren.* Utrecht, 1778, 8vo.

[2] On the relation of the ſenſes in the different claſſes of animals, the reader may conſult Dr. TROXLER's *Reſearches on Organic Phyſicks,* in German. Jena, 1804. 8vo.

§ 221. However univerſally animals may poſſeſs that feeling, which makes them ſenſible to the impreſſions of warmth and cold, very few poſſeſs, like the human ſubject, organs excluſively appropriated to the ſenſe of touch, and expreſsly conſtructed for the purpoſe of feeling, examining, and exploring the qualities of external objects.

This ſenſe appears, according to our preſent ſtate of knowledge, to exiſt only in three claſſes of the animal kingdom; viz. in moſt of the mammalia, in a few birds, and probably in inſects.

(A) Mammalia.

§ 222. The ſtructure of the organ of touch is the moſt perfect, and ſimilar to that of the human ſubject, in the quadrumana. The ends of their fingers, particularly of the poſterior extremities, are covered with as ſoft, and delicately organized a ſkin, as that which belongs to the correſponding parts in man.

Several of the *digitata* are probably provided with this ſenſe. The organization of the under ſurface of the front toes of the racoon (*urſus lotor*), and the uſe which the animal makes of thoſe parts, prove this aſſertion.

It is not ſo clear that we are authoriſed in conſidering the ſnout of the mole[3] and pig[4], not to mention the tongue of the ſolidungula and biſulca[5], or the ſnout of theſe and other animals[6], as true organs of touch according to the explanation above laid down[7].

§ 223. There would be more reaſon for aſcribing this ſenſe to the proboſcis of the elephant. (See note (A) at the end of the chapter.)

I think, however, that the ornithorhynchus clearly poſſeſſes an organ of touch. In this curious animal, as in the duck, &c. the ſenſe in queſtion reſides in the integuments, which cover the expanded portion of its jaws, particularly the upper one; this part is moſt copiouly ſupplied with nerves from the fifth pair, and chiefly from its ſecond branch, diſtributed juſt in the ſame manner as they are on the correſponding parts of the ſwimming birds.

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[3] Derham's *Phyſico. Theology*, p. 206, not 60.

[4] Darwin's *Zoonomia*, tom. 1, p. 162.

[5] Buffon *Hiſtoire des Oiſeaux*, tom. 1, p. 47.

[6] Buffon *Hiſtoire Naturelle*, tom. 3, p. 360.

[7] Much leſs can we ſuppoſe the long briſtly hairs, which conſtitute the whiſkers of the cat-kind, and other mammalia, to be organs of touch in the ſenſe we are now conſidering, although they may be ſerviceable, when they come in contact with any object, in warning, and making the animal attentive. See Darwin, *loc. cit.* Wiedemann in the *Göttingen Literary Notices*, 1798, p. 210. Albers, ibid. 1803, p. 603. and Vrolik *over het nut der Knevels by viervoetige Dieren.* Amſt. 1800. 8vo.

(B) BIRDS.

§ 224. The ſtructure of the organ of touch in the ornithorhynchus, which has been juſt deſcribed, is exactly ſimilar to that of geeſe and ducks. The bill of theſe birds is covered with a very ſenſible ſkin, ſupplied with an abundance of nerves from all the three branches of the fifth pair. This apparatus enables them to feel about for their food in mud, where they can neither ſee nor ſmell it.

(C) AMPHIBIA.

§ 225. It has been ſaid of ſerpents[8] with more ingenuity than truth, that their whole body is a hand; by which they gain juſt notions of the tangible properties of bodies. There is much more foundation for ſtating that the ſenſe of touch, which is here meant, does exiſt in any of the amphibia.

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[8] GIRTANNER in his Expoſition of the DARWINIAN ſyſtem, pt. 1, p. 124.

(D) FISHES.

§ 226. Concerning this claſs, the remark, which was made on the amphibia, may be repeated; although ſeveral fiſhes poſſeſs an acute feeling on he abdomen, and in the lips[9].

(E) INSECTS.

§ 227. All the obſervations and inveſtigations of the ſtructure of the antennæ, thoſe peculiar organs, which exiſt univerſally in the more perfect inſects; ad of the uſe, which theſe animals generally apply them to; lead us inevitably to the concluſion, that they really are, what their German name[10] imports, proper organs of touch; by which the animal examines and explores ſurrounding objects[11]. Such organs are particularly neceſſary to inſects, on account of the inſenſibility of their external coat, which is generally of a horny conſiſtence; and alſo from their eyes being deſtitute in moſt inſtances, of the power of motion.

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[9] LA CEPEDE, *Hiſtoire Naturelle des Poiſſons*, tom. 1. Diſcourſ. p. 65.

[10] *Fühlhorner:* the literal tranſlation of which is *Feeling Horns*.

[11] See LEHMANN *de Antennis Inſectorm.* Diſſ. 1, 2. Lond. 1799. 8vo. and KNOCK's *New Contributions to the Knowledge of Inſects.* pt. 1. Leipzig, 1801. 8vo. p. 33.

§ 228.

(F) VERMES.

§ 228. It ſeems more doubtful whether the tentacula of ſeveral vermes, and particularly the arms of the cuttle-fiſh [12], can be conſidered as organs of touch, in the more limited ſenſe, to which we have confined that word [13].

Additional Note to the Seventeenth Chapter.

(A) Bats have been ſuppoſed to poſſeſs a peculiar power of perceiving external objects, without coming actually into contact with them. In their rapid and irregular flight amidſt various ſurrounding bodies, they never fly againſt them: yet it does not ſeem that the ſenſes of hearing, ſeeing, or ſmelling, ſerve them on theſe occaſions; for they avoid any obſtacles with equal certainty when the ear, eye, and noſe are cloſed. Hence naturaliſts have aſcribed a ſixth ſenſe to theſe animals. It is probably analogous to that of touch. The nerves of the wing are large and numerous, and diſtributed in a minute plexus between the integuments. The impulſe of the air againſt this part may poſſibly be ſo modified by the objects near which the animal paſſes, as to indicate their ſituation and nature.

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[12] BUFFON, *Hiſtoire Naturelle*, tom. 3, p. 360.

[13] See LEHMANN *de Senſibus Externis Animalium Exſanguium.* Goetting. 1798. 4to. p. 43. F. I. SCHELVER *Eſſay towards the Natural Hiſtory of the Organs of Senſe in Inſects and Vermes.* Goett. 1798. 8vo. p. 28; and DRAPARNAUD, *Tableau des Molluſques Terreſtres and Fluviatiles de la France.* Montpellier. 1801. 8vo. p. 8.

CHAPTER XVIII.

ON THE TONGUE.

§ 228. WE are not juſtified in conſidering the tongue as an organ of taſte in all animals, becauſe it is ſubſervient to that function in the human ſubject, and in ſome other inſtances. We have already obſerved, that this organ in many caſes merely ſerves for taking in the food[1]; and it is at leaſt very doubtful whether it poſſeſſes the ſenſe of taſte in ſeveral others. Yet, on the contrary, we ſhould not be warranted in denying the exiſtence of the ſenſe in theſe animals, nor even in ſuch as are entirely deſtitute of a tongue: for this function may be exerciſed by other parts[2]. Leſs, however, can be concluded with any certainty à priori, on this, than on any of the five ſenſes.

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[1] The lingual bone *(os hyoides)* of the three firſt claſſes of animals, varies according to the different methods in which they take their food. Many excellent remarks on this ſubject may be ſeen in FAB. AB AQUAPENDENTE *de Larynge*, p. 276; and in CASSERIUS *de Vocis Organis*, with excellent delineations.

The curious lingual bone of the walrus and porpoiſe will be deſcribed in the 2nd vol. of DR. ALBER's *Contributions*.

[2] I have ſeen an adult, and in other reſpects well-formed man, who was born without a tongue. He could diſtinguiſh never-

(A) MAMMALIA.

§ 229. No animal poſſeſſes a tongue exactly like that of the human ſubject. The form of the organ differs conſiderably in the ſimiæ, being longer and thinner; and the papillæ, which cover its upper ſurface, are very different[3].

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nevertheleſs very eaſily the taſtes of ſolutions of ſalt, ſugar, and aloes, rubbed on his palate, and would expreſs the taſte of each in writing. Why then may not thoſe animals, which either have no tongue, or one not calculated for an organ of taſte, poſſeſs this ſenſe in ſome of the neighbouring parts? I cannot however agree with that ingenious anatomiſt GREW (in his *comparative anatomy of ſtomachs and guts*, p. 26.), when he conſiders the internal ſurface of the three firſt ſtomachs of the biſulca, to be an organ of taſte; particularly ſince WEPFER and others have remarked the enjoyment, which is connected with the ſecond maſtication of the food in ruminating animals.

[3] Thus the length of the tongue of the commoneſt kind of tailleſs ape (*ſimia ſylvanus*), which now lies before me, is three times greater than its breadth. It has three *papillæ petiolatæ*, or *fungiformes*, at its poſterior part, arranged in the form of a triangle. Before theſe, and along the two ſides of the tongue, are about two hundred *papillæ obtuſæ*, appearing like white grains. Theſe are not all of the ſame ſize; but they may be diſtinguiſhed from the *papillæ conicæ*, which cover the reſt of the tongue's ſuperior ſurface, much more eaſily than in the human tongue.

§ 230. Moſt of the herbivorous mammalia, particularly among the biſulca, have their tongue covered with a firm and thick cuticular coat; which forms numberleſs pointed papillæ directed backwards. Theſe muſt aſſiſt, according to their conſiſtence and direction, at leaſt in the animals of this country, in tearing up the graſs. Animals of the cat kind have their tongue covered with ſharp and ſtrong prickles, which muſt enable the animal to take a firm hold. Similar pointed proceſſes are found in ſome other animals; as in the bat-kind, and the opoſſum.

There ſeems to be no doubt that in all the mammalia which we have now conſidered, the tongue is an organ of taſte, at leaſt towards its anterior part.

The toothleſs animals, on the contrary, as the ant-eater* and manis, which ſwallow their aliment whole, have a long worm-like tongue, which is obviouſly capable of no other uſe than that of taking their food.

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* The tongue of a two-toed ant-eater, which I diſſected, was three inches and a half long, and no larger than a crow-quill at its root. It was, generally ſpeaking, cylindrical; but marked with a ſcarcely perceptible groove on its ſuperior ſurface. Two very ſmall foramina cæca were found near the root. The lingual bone was ſtrong, but not remarkably large, and in ſhape like a horſe-ſhoe. Its muſcles, on the contrary, as the geniohyoideus, mylohyoideus, and particularly the geniogloſſus, were remarkably large and ſtrong.

(B) Birds.

§ 232. All birds poſſeſs a tongue: for even the pelican, in which its exiſtence has been denied, poſſeſſes a manifeſt rudiment of the organ. Probably, however, it ſerves the purpoſe of an organ of taſte in very few genera. Yet this is the caſe with ſome predacious and ſwimming birds; as alſo with moſt of the pſittaci; which poſſeſs a ſoft thick tongue covered with papillæ, and moiſtened with a ſalivary fluid: they really taſte different fluids, and ſoft kinds of food, and ſelect that which is the moſt agreeable.

§ 233.

As we are now conſidering the tongue in its office of aſſiſting in taking in the food, this ſeems to be the proper place for noticing the worm, as it is called, of the dog's tongue. It is a tendinous faſciculus of fibres running lengthwiſe under the tongue, as far as its apex, and lying rather looſe in a kind of membranous ſheath, without being connected, like a true tendon, to any of the neighbouring muſcles. By an old prejudice, which has ſubſiſted at leaſt ſince the time of Pliny, its extirpation is conſidered as a preſervative againſt hydrophobia. Concerning the ſtructure of this curious, and in ſome reſpects enigmatical part, ſee Morgagni *de Sedibus et Cauſis Morborum*, tom. 1, p. 67. Venet. 1761, folio. Casserius thought that it aſſiſted the dog in lapping up

§ 233. In ſeveral other birds, on the contrary, the tongue is horny, ſtiff, not ſupplied with nerves, and conſequently unfit for an organ of taſte. One ſtriking example will ſupply the place of many. The tongue of the toucan *(Ramphaſtos)* is ſometimes ſeveral inches in length, yet ſcarcely two lines broad at its root. It has the appearance, throughout, of a piece of whalebone; and its margins are fibrous.

§ 234. The form[4] and mechaniſm of the tongue vary much in the different genera and ſpecies of this claſs. Two inſtances deſerve particular notice: that of the wood-pecker, and the cock of the woods. The tongue of the former bird is generally ſaid to be very long; but it is not ſo. That part, which correſponds to the tongue of other birds, is remarkably ſhort: it is merely a ſharp-pointed horny portion, with its ſides barbed. Behind this is a very ſingular os hyoides; of a ſlender appearance, but having very long crura. It conſiſts of five cartilaginous portions; viz. one ſingle piece, and two pairs. In the quieſcent ſtate of the organ, the for-

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up fluids in the peculiar way which they do: and his opinion is ſupported by this circumſtance, that an opoſſum, which I kept alive for ſome time, and which took fluids in the ſame manner as dogs do, had a ſimilar part under the tongue.

[4] See the plates in J. C. SCHOEFFER's *Elementa Ornithologica* Ratiſbon, 1774. 4to.

mer lies in a fleſhy, and very extenſile ſheath of the bill. The firſt pair of cartilages is articulated with this; and they are placed at the ſides of the neck. The ſecond pair, commencing from theſe, run completely over the cranium, under the integuments; and advancing from behind, forwards, their converging extremities are placed together in a kind of groove, and commonly terminate anteriorly by an attachment to the right ſide of the upper jaw. This poſterior pair of cartilages may therefore be compared to ſteel ſprings, which actuate the whole organ[5]. When the tongue is to be darted out, the anterior pieces are drawn together, and enter the ſheath of the ſingle portion, extended for their reception. The tongue is thus elongated, and admits of being thruſt out ſome inches.[6]

The tongue of the cock of the woods is ſtill more ſingular: that organ, together with the larynx, lies deep in the œſophagus, but admits of being quickly elevated and thruſt forth by means of conſiderable muſcles[7].

(C) AM-

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[5] This is an elegant example of the great ſhare, which mere elaſticity poſſeſſes in the performance of ſome functions of the animal economy.

[6] See MERY, in the *Memoires de l'Acad. des Sciences*, 1709, p. 85. WALLER, in the *Philoſ. Tranſ.* vol. 29, p. 509: and WOLF, in VOIGT'S *Magazine*, pt. 2, of the new ſeries, p. 468.

[7] FRISCH *on the German Birds*, tab. 108. SCHNEIDER'S Com-

(C) AMPHIBIA.

§ 235. We ſhall ſelect a few examples of the chief varieties in this claſs of animals.

The crocodile's tongue (the very exiſtence of which has been denied from the time of HERODOTUS down to HASSELQUIST) is ſmall; poſſeſſes very little motion; and is in a manner adherent between the two ſides of the lower jaw[8]. The ſalamander reſembles this. A very different ſtructure is preſented in the curious tongue of the chamæleon; the mechaniſm of which may be compared in ſome reſpects with that of the woodpecker. Yet its form is very different; for the anterior extremity of the organ is club-ſhaped; and is hollowed out on its upper ſurface[9]. (See note (A) at the end of the chapter.)

The tongue of ſome teſtudines is thickly co-

Commentary on the Works of FREDERIC II. tab. 2; and GILIBERT, *Médecin Naturaliſte.* Lyons, 1800, 8vo. p. 294.

[8] C. G. DE RHOER, *de Fide Herodoti rité æſtimanda*, in the *Verhandelingen van Teylers tweede Genootſchap*, pt. 7, p. 104. L. V. HAMMEN, *de Herniis*, p. 105. *Nouvelles de la Republique des Lettres*, Oct. 1688, p. 1125.

[9] Beſides the works which have been already quoted on the anatomy of this animal, ſee HUSSEM in the *Verhandelingen van de Maatſchappye te Haarlem*, v. 8, pt. 2, p. 228. DUVERNOY in the *Bulletin de la Soc. Philom.* tom. 3; and MILLER *Icones Animal. et Plantar.* tab. 2.

vered on its anterior margin with long fibrous papillæ[10].

The ſoft, flat, and fleſhy tongue of the frog, lies, in the quieſcent ſtate, in a direction from before, backwards. It is firmly attached behind the arch of the lower jaw; and its looſe end is turned backwards, ſo that the ſemilunar notch of its anterior margin correſponds to the rima glottidis. They ſeize their prey by turning the tongue forwards, and thruſting it out of the mouth.

§ 236. The tongue of ſerpents is attached, and ſituated in the ſame manner as in the frog[11]: but it is round and ſlender: its apex is bifid, and the root reſts in a kind of fleſhy ſheath, being capable of protruſion and retraction at pleaſure[12].

(D) Fishes.

§ 237. There is little to be ſaid concerning the tongue of this, and the two following claſſes. It is doubtful whether it be an organ of taſte, and in what degree it may ſerve that purpoſe.

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[10] I have obſerved this in the *Teſtudo Græca* from Mogador. The form of the os hyoides in the teſtudines may be ſeen in Caldesi, tab. 8.

[11] Seetzen in Meyer's *Zoological Archives*, pt. 2, p. 65.

[12] *Delineations of Objects in Natural Hiſtory*, pt. 4. tab. 37, in the boa and rattle-ſnake. The curious os hyoides of ſerpents, with two cartilaginous portions running along the trachea, is repreſented by Tyson, *Philoſ. Tranſ.* vol. 13, p. 68, fig. 5.

It appears at leaſt in fiſhes to poſſeſs no manifeſt papillæ[13]; and in many of this claſs is covered with teeth.

That, which is commonly called the tongue in ſome fiſhes, as the carp, is a glandular body, attached to the palate, and extremely irritable in the living animal[14].

(E) INSECTS.

§ 238. The organ which is commonly conſidered as the tongue of inſects[15], merely ſerves for taking in the food[16]. But the accurate obſervations of profeſſor KNOCH[17], render it very probable that the poſterior pair of palpi, or feelers, poſſeſſes the power of taſte in ſeveral of this claſs.

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[13] LORENZINI's *Obſervations on the Torpedo*, in Italian, p. 41.

[14] *Obſervat. Colleg. privat. Amſtelod.* vel 1, p. 40.

[15] A very accurate account of this part, and its varieties, illuſtrated with numerous figures, by an excellent entomologiſt, J. C. G. KARSTEN, of Roſtock, now lies before me in manuſcript, and will ſoon be made public.

[16] SCHELVER, *loco citato*, p. 39. A. W. KNOCH, *Contributions to the Knowledge of Inſects*, pt. 1, 1801, 8vo. p. 40, tab. 1, fig. 30. The tongue of the May-beetle (*Scarabæus Melolontha*) is repreſented.

[17] *Loc. cit.* p. 32, tab. 1, fig. 9, of the *Scarabæus Friſchii*, tab. 8, fig. 4, of the *Carabus unicolor*.

(F) VER-

(F) VERMES.

§ 239. In the mouth of ſome molluſca,[18] and ſnails[19], an organ is found, which has generally from its ſituation been taken for the tongue. But none of the obſervations, which have been hitherto adduced reſpecting its functions, are ſufficiently deciſive to juſtify us in ſetting it down as an organ of taſte.

Additional Note to the Eighteenth Chapter.

(A) The tongue of the chameleon diſplays a very curious mechaniſm. It is contained in a ſheath at the lower part of the mouth; and has its extremity covered with a glutinous ſecretion. It admits of being projected to the length of ſix inches; and is uſed in this manner by the animal, in catching its food; which conſiſts of flies, &c. It is darted from the mouth with wonderful celerity and preciſion; and the viſcous ſecretion on its extremity, entangles the ſmall animals which conſtitute the food of the chameleon.

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[18] SWAMMERDAM of the cuttle-fiſh, p. 882, tab. 50, fig. 4, 5.

[19] Of the *helix pomatia*, ibid. p. 109, tab. 5, fig. 3.

CHAPTER XIX.

ON THE ORGAN OF SMELLING.

§ 240. THE ſenſe of ſmelling prevails much more extenſively in the animal kingdom, than that of taſte: ſince it not only aſſiſts ſeveral genera in ſelecting their food, which they have not afterwards the power of taſting; but is alſo of ſervice in finding out proper objects for the ſatisfaction of their ſexual appetite. Yet there is much doubt reſpecting the organs of this ſenſe in the two claſſes of white-blooded animals[1].

§ 241. We can determine the degree of acuteneſs of this ſenſe by the inſpection of the cranium, in the four-footed mammalia[2], (taking the term in its moſt extenſive ſenſe, in which it will include the quadrumana and bats[`]. Three circumſtances principally determine our judgement on this point.

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[1] On the organ of ſmelling in ſeveral genera of the four claſſes of red-blooded animals, ſee the 2nd vol. of CUVIER's *Leçons d'Anat. comp.* SCARPA, *Diſquiſitiones Anatomicæ de Auditu et Olfactu.* And HARWOOD's *Syſtem of comparative Anatomy and Phyſiology;* which is tranſlated into German, with remarks and additions, by C. R. WIEDEMANN, Berlin, 1799, 4to.

[2] F. C. ROSENTHAL *Diſſ. de Organo Olfactus quorundam Animalium,* Jena, 1802, 4to.

1ſt, The ſtructure of the ethmoid bone, and particularly the number and arrangement of thoſe openings in its ſuperior or horizontal lamina, which tranſmit the filaments of the olfactory nerve. 2ndly, The formation of the inferior conchæ narium, or turbinated bones. 3rdly, The exiſtence and relative magnitude of thoſe cavities of the internal noſe, particularly the frontal ſinuſes, which contribute to the organ of ſmelling.

§ 242. The hedge-hog and mole, the animals of the weaſel, bear, dog, and cat-kinds, moſt of the biſulca, and the elephant, afford examples of a very complicated formation of the ethmoid bone; both in regard to the elegant ſtructure of its cribriform lamella, and to the wonderful convolutions of its turbinated portions; which procure as large a ſurface as poſſible within the confined ſpace of the naſal cavity, for the application of the Schneiderian membrane. All theſe animals are well known for the remarkable acuteneſs of their ſenſe of ſmelling.

The ethmoid bone is remarkably narrow, and imperfectly developed in moſt of the quadrumana. As there is not ſufficient ſpace left for it between the orbits, which lie cloſe together[3], (§ 20.) it is placed deeper in the noſe; ſo that the olfactory nerves deſcend between the orbital portions of the frontal bone, as in a canal, the bottom of which is formed by the cribriform lamella, ſmall and inconſiderable, and perforated by few apertures[4].

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[3] In the ſkull of a cercopithecus capucinus in my poſſeſſion, the partition between the two orbits, which ſpace in the human

The cetacea have no ethmoid bone. They want alſo the firſt pair of nerves; and the firſt branch of the fifth pair ſeems to perform its functions.

§ 243. The *conchæ narium inferiores* are more or leſs convoluted, in proportion to the greater or leſs complication in the ſtructure of the upper ones. They are remarkably large in the biſulca[5]; and much convoluted in moſt of the predacious animals[6]. They are both large and wonderfully complicated in the ſeal[7].

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human cranium is filled by the ethmoid cells, and ſuperior turbinated bones, contains a large opening, which in the recent ſtate was probably cloſed by a portion of perioſteum.

[4] JOSEPHI, *Anatomy of the Mammalia*, vol. 1, p. 179, &c.

[5] See CASPAR BARTHOLIN, *Analecta Obſervationum*, in his *Specimen Hiſtoriæ Anatomicæ*, tab. 3, fig. 3, 4, of the ſheep; and MORAND, in the *Mem. de l'Acad. des Sciences*, an. 1724, tab. 24, of the ox.

[6] CASP. BARTHOLIN, *loco citato*, fig. 5, 6, of the hound, (*canis venaticus*).

[7] An excellent delineation of this part in the walrus, will appear in the 2nd part of ALBERS's Contributions

§ 244. The frontal ſinuſes[8] of the elephant[9] are larger than thoſe of any other animal; the pig, which has an acute ſenſe of ſmelling, comes next in order in this reſpect. Moſt of the mammalia, which poſſeſs proper horns, have theſe cavities extending more or leſs into thoſe proceſſes of the frontal bone, on which the horns are formed: this ſtructure is particularly obſervable in the wild goat *(capra ibex)*. They are generally large in the biſulca[10], the ſolidungula, and in moſt of the carnivorous mammalia. They are abſent on the contrary in the ſeal; in moſt of the rodentia; and the cetacea.

§ 245. The anomalous ſtructure of the elephant's proboſcis, or trunk, and the blowing-holes of the cetacea, muſt be noticed here; as theſe parts conſtitute prolongations and external openings of the noſe.

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[8] I have conſidered, in a more detailed manner, the ſtructure of theſe cavities in ſeveral genera and ſpecies of the different orders of mammalia in my *Proluſio de Sinibus Frontalibus*, Goetting, 1779, 4to, where I have endeavoured to ſhew, from comparative anatomy, that their uſe is to ſtrengthen the ſenſe of ſmelling; and that they are not ſubſervient to the formation of the voice.

[9] Stukely, in his *Hiſtory of the Spleen*, p. 101, tab. 5, fig. 2.

[10] They receive in the ſheep, as is well known, the larvæ of the œſtrus ovis; and caſes are not very uncommon in which other inſects, particularly the *ſcolopendra electrica*, have accidentally gained admiſſion into them in the human ſubject, and have cauſed diſtreſſing and tedious ſymptoms.

The former organ conſiſts of two canals, ſeparated from each other by an intervening partition. Innumerable muſcular faſciculi running in two directions, occupy the ſpace between theſe and the integuments. There are fibres of a tranſverſe courſe, paſſing like radii from the canals to the integuments[11]; and others, which run in a more longitudinal direction, but have their extremities turned inwards[12]. The former extend the trunk, without cauſing any contraction of the canals; the latter bend or contract it; and both tend to beſtow on it that wonderful mobility, which it poſſeſſes in every direction. (See note (A) at the end of the chapter.)

The blowing-hole of the cetacea is not a peculiar organ, diſtinct from the naſal openings, as ſeveral naturaliſts have imagined, but one and the ſame with theſe[13]. It does not however ſeem to be deſigned for an organ of ſmelling, but merely to be ſubſervient to reſpiration, and to the expulſion of the water which enters the mouth with the food[14]. (See note (B).

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[11] *Hiſt. des Animaux,* tom. 3, tab. 22, fig. 9; STUKELY, *loc. cit.* tab. 1, fig. 2.

[12] *Hiſt. des Animaux, loc. cit.* STUKELY, tab. 5, fig. 1.

[13] This has been correctly ſtated by TYSON in his *Anatomy of a Porpeſſe,* tab. 2, fig. 8, 9.

[14] CUVIER in the *Magaſin Encyclopedique,* an. 3, tom. 2, p. 299.

(B) BIRDS.

§ 246. The noſtrils open in the ſeveral genera of this claſs in very different parts of the upper mandible; in ſome, as the puffin *(alca arctica)*, the openings are placed at the margins of the bill, and are ſo ſmall, that they might be eaſily overlooked[15].

§ 247. Birds have no proper ethmoid bone: their olfactory nerves paſs through the orbits to the noſe, and are diſtributed on the pituitary membrane, which covers two or three pairs of bony[16] or cartilaginous[17] conchæ narium *(bullæ turbinatæ* or *tubulatæ veſicæ*[18]*)* of various forms and ſizes[19]. (See note (C).

(C) AMPHIBIA.

§ 248. The organ of ſmelling is leſs clearly developed in this claſs of animals. Yet we diſcover two cartilaginous eminences, which may be compared to the conchæ of warm-blooded animals[20]. (See note (D).

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[15] This may ſerve as an excuſe for the erroneous repreſentation of BUFFON, that ſeveral birds are entirely unprovided with noſtrils, and that they ſmell by means of the palatine openings of the naſal cavity.

[16] The crane has very large turbinated bones.

[17] This is the caſe in the toucan, (*Ramphaſtos*).

[18] They are excellently deſcribed under this name by SCHNEIDER, *de Oſſe Cribriformi*, p. 180.

[19] See SCARPA's repreſentation of the nerves of the noſe in the gooſe, turkey, and heron, *de Auditu et Olfactu*, tab. 3.

(D) FISHES.

§ 249. Moſt of theſe ſeem to have double noſtrils on each ſide: for the openings are furniſhed with a valve-like moveable membrane, which appears like a partition[1].

§ 250. Behind theſe is generally found, inſtead of conchæ narium, a very elegantly plaited membrane, diſpoſed in ſemicircular folds, and having the olfactory nerves diſtributed on it[2].

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[20] SCARPA, tab. 5, in a turtle and viper.

[1] It was formerly ſuppoſed, that this part ſerved alſo for the organ of hearing in fiſhes; and this erroneous opinion has been revived even in modern times; but it cannot be neceſſary to refute ſuch an abſurdity now.

[2] See repreſentations of this part, in the raia clavata, by SCARPA, tab. 1, fig. 2: in the ſkate *(raia batis)* by HARWOOD, tab. 7: in the ſhark, by STENONIS, in his *Specimen Myologiæ*, tab. 7, fig. 1: in the *Squalus Catulus*, by SCARPA, tab. 2, fig. 6, 7: in the frog-fiſh *(lophius piſcatorius)* ibid. tab. 1, fig. 3: in the pike, by CASSERIUS, *de Auditus Organis*, tab. 12; by CAMPER, in his *ſmaller Writings*, pt 2, tab. 2, fig. 1; SCARPA, tab. 2, fig. 1, 2; and HARWOOD, tab. 5, fig. 4: in the carp, ibid. tab. 2, fig. 4, 5.

Some detached remarks on the organ of ſmelling, in particular fiſhes, are given by MORGAGNI in his *Epiſt. Anat.* p. 350, Padua, 1764, fol.

(E) INSECTS.

§ 251. Numerous facts have long ago proved that ſeveral inſects can diſtinguiſh the odorous properties of bodies even at conſiderable diſtances. But the organ, in which this ſenſe reſides, has not hitherto been clearly pointed out.

Since all red-blooded terreſtrial animals ſmell only through the medium of the air, which they take in in inſpiration, ſeveral naturaliſts have ſuppoſed, that the ſtigmata of inſects are to be conſidered as organs of ſmelling[3]. Others aſcribe this office, and with ſome probability, to the anterior pair of palpi[4].

(F) VERMES.

§ 252. Several animals of this claſs appear to have the ſenſe of ſmelling: as many land-ſnails (*helix pomatia*[5], &c.). But the organ of this ſenſe is hitherto unknown; perhaps it may be the ſtigma thoracicum.

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[3] This was the opinion of S. REIMARUS, "*on the Inſtincts of Animals,*" in German, p. 308, ed. 3rd. See alſo DUMERIL in the *Magaſin Encyclopédique,* an. 3, tom. 2, p. 435.

[4] KNOCH, in his *new Contributions to the Knowledge of Inſects,* p. 32, tab. 1, fig. 8, and tab. 8, fig. 3, of the *ſcarabæus friſchii and carabus unicolor.*

[5] SWAMMERDAM, p. 110.

Additional Notes to the Nineteenth Chapter.

(A) Cuvier has given a more detailed deſcription of the elephant's trunk in the laſt vol. of his *Leçons d'Anat. comp.* p. 283—289; and has alſo repreſented the part in the 29th plate of the ſame volume.

The more longitudinal fibres are divided at ſhort intervals by tendinous interſections, which enable the animal to bend any part of the organ, and to give it any requiſite degree of curvature. The ſame ſtructure will confer a power of bending different parts of the trunk in oppoſite directions; indeed there is no kind of curvature which may not be produced by theſe longitudinal fibres. Theſe faſciculi occupy the external ſurface of the organ. The tranſverſe fibres are not all arranged like radii round the canals; but ſome paſs acroſs from right to left, and muſt therefore affect the diameter of thoſe tubes by their action. The whole of theſe muſcular faſciculi are ſurrounded and connected together by a white, uniform, adipous ſubſtance. The tranſverſe ones are not more than a line in thickneſs. If the number of theſe, which appears on a tranſverſe ſection, be aſcertained; and if thoſe portions of the longitudinal faſciculi, which paſs from one tendon to another, be reckoned as ſeparate muſcles, (for they muſt have a ſeparate power of action) the whole trunk will contain about thirty or forty thouſand muſcles; which will account ſatisfactorily for the wonderful variety of motions which this admirable organ can execute, and for the great power which it is capable of exerting.

(B) The blowing-hole of the whales ſerves as well for reſpiration, as for the rejection of the water which enters with their food. In conſequence of its ſituation at the top of the head, it is eaſily elevated beyond the ſurface of the ſea, while the mouth is uſually entirely under water.

The opening in the bones of the head is divided into two by a partition of bone; and is furniſhed with a valve opening outwards. On the outſide of this opening are two membranous bags, lined with a continuation of the integuments, and opening externally. The water, which the animal wiſhes to diſcharge, is thrown into the fauces, as if it were to be ſwallowed; but its deſcent into the ſtomach is prevented by the contraction of the circular fibres of the œſophagus. It therefore elevates the valve placed at the entrance of the blowing holes, and diſtends the membranous bag, from which it is forcibly expelled by ſurrounding muſcular fibres.

This apparatus occupies the ſituation, which in other mammalia is filled by the noſe; which organ, together with the ſinuſes of the head, the olfactory nerve, &c. is entirely wanting in theſe animals.

(C) The olfactory nerve of birds comes off from the anterior extremity of the front lobe of the brain, and has therefore ſome analogy with the proceſſus mamillaris of quadrupeds. It paſſes along a canal to the noſe, and is diſtributed in a very beautiful and diſtinct manner on the pituitary membrane in many inſtances, as in the crane.

(D) The origin and courſe of this nerve are much the ſame in reptiles as in birds. In the turtle it is a large, ſtrong, and fibrous nerve, and its ramifications in the noſe are eaſily traced.

CHAPTER XX.

ON THE ORGAN OF HEARING.

§ 253. WE ſhould naturally expect to find an organ of hearing in moſt claſſes of animals [1], when we conſider the various ſervices, which this ſenſe performs; as, that of indicating the approach of danger, of conducting predaceous animals to their prey, and of bringing the two ſexes together for the purpoſe of copulation, &c. Red-blooded animals, without any exception, poſſeſs this organ. Analogous parts are found in ſome of the white-blooded; and ſeveral others certainly can hear, although the organ of that ſenſe has not been hitherto been aſcertained.

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[1] The following works may be conſulted for an account of the organ of hearing in the different claſſes of animals.

CASSERIUS *de Vocis Audituſque Organis*. Ferrara, 1600, fol. (The part relating to the ear is alſo contained in his *Pentæſtheſeion.)*

PERRAULT, *Eſſais de Phyſiqae*, tom. 2.

GEOFFROY *ſur l'Organe de l'Ouie*, &c. Amſterd. 1788-8.

SCARPA *de Auditu et Olfactu*.

COMPARETTI, *Obſervationes Anatomicæ de Aure Internâ comparata*. Patav. 1789-4.

MONRO's *three Treatiſes on the Brain, Eye, and Ear*. Edin. 1797-4.

HOME in the *Philoſ. Tranſ.* 1800, pt. 1.

(A) MAMMALIA.

§ 254. The four-footed mammalia are the only animals, which poſſeſs true external ears; and, even here, ſeveral inſtances occur, in which theſe parts are wanting; particularly among ſuch as live in the water, or under ground. They are not met with, for inſtance, in moſt of the ſeals, in the walrus, manati, duck-billed animal *(ornithorhynchus)*, and mole. On the contrary ſome have been ſaid to want external ears, who really poſſeſs them, as the *marmota* or *mus citillus*. Another error has been committed, in repreſenting the ears of a ſpecies of bat, belonging to this country, *(veſpertilio auritus)* as double[2]: whereas they are only of an immenſe ſize. The eſſential parts of the external ear agree on the whole with thoſe of the human ſubject*; but their general form is ſubject to great variety. In very few, except the quadrumana, do they reſemble thoſe of man; but this is the caſe in the porcupine. The cartilage is ſtronger, and more elaſtic in its ſtructure in the human ear, than in that of any other animal, in proportion to its ſize. In ſome inſtances, as the opoſſum (*didelphis marſupialis*), they are merely membranous.

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[2] Still more erroneous is an obſervation of HALLER; that theſe ears are to be conſidered as an accidental monſtroſity.

* The *lobulus* of the external ear is found in no animal but man.

§ 255. The external auditory paſſage is furniſhed with a valve in ſuch animals as go frequently into the water, by which they can cloſe it when they dive. The water-ſhrew (*ſorex fodiens*) affords an example of this ſtructure. The length, breadth, and direction of the meatus vary conſiderably in the different genera. It is very long and ſingularly tortuous in the duck-billed animal [3]. (See note (A), at the end of the chapter.)

§ 256. It is hardly neceſſary to ſtate that all mammalia have a *membrana tympani*, a *tympanum* ſituated within this, and an *Euſtachian tube* paſſing from that cavity to the fauces; except in the cetacea, where it opens in the blowing hole. (§ 245.) The membrane is rather concave on its outer ſurface, being ſlightly depreſſed in the middle. All the animals of this claſs are furniſhed with the two *feneſtræ*; the *f. ovalis*, which is filled by the baſe of the ſtapes; the *f. rotunda*, at which the ſcala tympani of the cochlea commences.

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[3] Home in the *Philoſ. Tranſ.* 1802, pt. 1, p. 70.

§ 257. In moſt of the four-footed mammalia, there is connected with the tympanum, another cavity; which, according to the ſituation of the bony organ that contains it, muſt be compared to the maſtoid cells in the temporal bone of man.

In ſeveral animals this organ forms a mere bony cavity (*bulla oſſea*): viz. in the dog, cat, martin, ſquirrel, hare, and ſome of the biſulca. An attempt at this ſtructure is to be ſeen in the cercopithci. In the horned cattle, on the contrary, and in the pig, the cavity is divided into cells by numerous bony plates, which ſomewhat reſemble the diviſions in a ripe poppy head[4].

§ 258. Warm-blooded quadrupeds have, like the human ſubject, three[5] *oſſicula auditus;* which on the whole reſemble in form thoſe of man. But the duck billed animal, whoſe ſtructure in every reſpect is ſo anomalous, has only two[6]; and on the contrary one or two additional ſmall bones are occaſionally found, particularly in ſome *biſulca*[7]. (See note (C).

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[4] Vesalii. *Anatomicarum Fallopii Obſervationum examen.* Venet. 1764, 4to, p. 20.

[5] That the *lenticulus* or fourth bone is only a proceſs of the incus, I have already ſhewn in my "*Hiſtory and Deſcription of the Bones of the Human Body.*" in German. p. 144. (See note (B).

[6] Home, *loco citato.*

§ 259. The part which is termed the labyrinth of the ear, as far as it has been hitherto inveſtigated in the four-footed mammalia, ſeems to agree on the whole, in its eſſential parts, with that of the human ſubject. But the cochlea (which belongs indeed excluſively to this claſs) has in ſome caſes a turn more than in man; not to mention other differences of leſs importance[8].

§ 260. In addition to what has been obſerved reſpecting the Euſtachian tube of the cetacea, ſome other parts of the organ of hearing exhibit ſuch peculiarity in theſe animals, and deviate ſo widely from thoſe of warm-blooded quadrupeds, that they require particular notice[9].

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[7] Adair in Cowper's *Myotomia Reformata.* Lond. 1694, 8vo. p. 70. fig. 9.

Teichmeyer, *Vindiciæ quorundam Inventorum Anatomicorum.* Jenæ, 1727-4. fig. 5.

[8] The reader may conſult on this ſubject the following works, beſides thoſe which have been already referred to. Scarpa *de Structurâ Feneſtræ Rotundæ Auris.* Mutin. 1777, 8vo. p. 94. P. F. Meckel *de Labyrinthi Auris Contentis.* Argent. 1774. 4.

[9] On the organ of hearing in the true whale *(balæna)*, ſee Camper's *ſmaller Writings.* vol. 2, pt. 1. In the ſpermaceti whale *(phyſeter)* ibid. vol. 1, pt. 2. In the dolphin *(delphinus delphis)*,

Their want of external ear is well known. The opening of the meatus is remarkably ſmall. The bony part of the organ is looſely connected to the ſkull in the dolphin and porpoiſe; and it is completely ſeparate in the proper whales (*balænæ*) and cachalot (*phyſeter*).

The hard bony ſubſtance, which was formerly very erroneouſly called *lapis manati* or *tiburonis*, is merely the tympanum, and *bulla oſſea* of the whale.

The oſſicula auditus, and the labyrinth, particularly the bony canals (*canales ſemicirculares*), which for this very reaſon were long overlooked, are remarkably ſmall in the cetacea.

(B) BIRDS.

§ 261. This whole claſs[10], as well as the following ones, has no cartilaginous external ear, which belongs, therefore, excluſively to the mammalia.

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delphis), KLEIN Hiſt. Nat. Piſcium. pt. 1, p. 29, tab. 5, fig. 1-4, and 7-9 In the ſpermaceti whale, porpoiſe (*delphinus phocæna*), and dolphin: MONRO's *three Treatiſes*, &c. tab. 5, 6. and his *Phyſiology of Fiſhes*, tab. 35.

[10] On the organ of hearing in this claſs, ſee ALLEN MOULINS in the *Philoſ. Tranſ.* vol. 17, p. 712. VICQ. D'AZYR in the *Mem. de l'Acad. des Sciences*, 1778, p. 381. SCARPA *de Structurâ Feneſtræ Rotundæ Auris*, p. 101. and *de Auditu*. GALVANI in the *Comment. Inſtit. Bonon.* tom. 6. p. 420.

This apparent deficiency is compenſated in birds, particularly in thoſe of the rapacious kind, by the regular arrangement of the feathers round the opening of the meatus. Several alſo, chiefly of the laſt mentioned claſs, and particularly among the owls, have a peculiar valve placed at the opening, partly of a membranous, partly of a muſcular ſtructure[11].

§ 262. The *membrana tympani* of birds is convex on its outer ſurface; and the *tympana* of the two ears are connected together by the air-cells of the cranium[12].

They have a ſingle *oſſiculum auditus*, connecting the membrana tympani with the feneſtra ovalis, and conſequently ſupplying the place of the malleus and ſtapes of the mammalia.

The part correſponding to the malleus, is generally cartilaginous, and not provided with any *tenſor tympani*.

The *euſtachian tubes* have a kind of common opening on the arch of the palate.

§ 263. The *labyrinth* is diſtinguiſhed by large canals, projecting from the cranium, and not hollowed out of a hard bony ſubſtance, as in the mammalia; and by the want of *cochlea.* Inſtead of the laſt mentioned part, birds have a ſhort, obtuſe, and hollow bony proceſs, paſſing obliquely backwards from the veſtibulum; and divided by a partition, like the cochlea of mammalia, into two *ſcalæ*, one of which terminates at the feneſtra rotunda. This part receives a portion of the auditory nerve, as the cochlea does.

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[11] Klein *Stemmata Avium*. tab. 10, fig. 2. Comparetti, tab. 2, fig 2, he compares this part to the concha of the human ear.

[12] Mr. Home has obſerved the ſame kind of communication, by the means of the cells of the cranium, in the ele-

(C) AMPHIBIA.

§ 264. The different orders, and genera of this claſs[13] exhibit greater variety in the ſtructure of the organ of hearing than the two former, or the following claſs. Hence the principal variations muſt be ſeparately conſidered.

§ 265. Turtles, frogs, and moſt ſpecies of the lizard kind, poſſeſs, beſides ſemicircular canals, a tympanum and euſtachian tube, like warm-blooded animals.

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[13] In the 7th vol. of the *Comment. Inſtit. Bonon.* BRUNELLI has deſcribed and delineated the organ of hearing in the turtle, tortoiſe, frog, lizards, and ſerpents. COMPARETTI has alſo exhibited figures of theſe genera and orders, tab. 2, fig. 13-35. And SCARPA has given moſt beautiful engravings of the ear in the turtle, crocodile, green lizard, ſalamander, viper, and blind-worm, *de Auditu*, tab. 5. See alſo MONRO on the turtle in the *Phyſiology of Fiſhes.*

mals. Both the latter parts, however, as well as the oſſicula auditus, are wanting in the ſalamander.

The *membrana tympani* of the turtle reſembles a maſs of cartilage; and is covered externally by the common integuments. Their ſingle *oſſiculum* reſembles that of birds.

Frogs have a large membrana tympani level with the ſurface of the body; a wide opening the Euſtachian tube at the fauces; two cartilaginous oſſicula; and a rudiment in the veſtibulum of thoſe ſoft ſtony ſubſtances, which are found in a more conſpicuous form in the lizards and ſerpents, and in the three following claſſes.

The crocodile is the only inſtance, in which there is a ſort of external meatus in the claſs amphibia. This animal, as well as the lizards, poſſeſſes *oſſicula*, and the above-mentioned ſtony concretions in the veſtibulum.

The want of tympanum in the ſalamander has been already mentioned. The foramen ovale in this animal is merely cloſed by a portion of cartilage, and the veſtibulum contains a ſoft ſtone.

§ 266. The ſerpents, with a very few exceptions, as the blind-worm[14] *(anguis fragilis)* have neither tympanum, nor Euſtachian tube. They have a kind of rudiment of oſſiculum.

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[14] Scarpa, *loco citato*, p. 26.

(D) Fishes.

§ 267. It is only in ſome genera of cartilaginous fiſhes, viz. the ſkate and ſhark, that a tubular appendix of the veſtibulum is continued backwards and outwards, ſo as to repreſent a rudiment of a tympanum.

§ 268. The other animals of this claſs[15] have no ſimilar part; but their organ of hearing conſiſts of three large canals, which are generally ſeen to project into the cavity of the cranium. Oppoſite to the termination of the auditory nerves on the veſtibulum, one, two, or three neatly formed ſtones are found. Theſe are as white as porcellaine, particularly in ſeveral of the bony fiſhes, and very dry and brittle in their texture[16].

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[15] See Klein, *Mantiſſa Ichthyologica*, Lips. 1746, 4to.

Kölreuter in the *Nov. Comment. Acad. Petrop.* tom. 17, p. 521. Of the ſturgeon, and beluga (*acipenſer ſturio, and huſo*).

Camper's *ſmaller Writirgs*, vol. 1, pt. 2, tab. 2, of the cod; vol. 2, pt. 2, tab. 1-3, of the frog-fiſh, (*lophius piſcatorius*), pike, and ſkate.

The organ is delineated in ſeveral fiſhes, in the work of Comparetti, tab. 3; in Scarpa, tab. 1, 2, 4; and in Monro's two works. See alſo J. Hunter's *Obſervations on the Animal Economy*, p. 69.

[16] Klein, *Hiſt. Piſcium*, pt. 1, tab. 2.

§ 269. The internal ear of fiſhes is diſtinguiſhed from that of the other three claſſes of red-blooded animals, by this remarkable peculiarity; that it grows, as the fiſh increaſes in ſize, and conſequently that its magnitude is in the direct ratio of the bulk and age of the animal. (See note (D).

(E) INSECTS.

§ 270. There is no doubt that ſeveral inſects poſſeſs the ſenſe of hearing[17]; but the organ of this ſenſe is very uncertain. In ſome of the larger animals of the genus cancer a part can be diſtinguiſhed, which ſeems to be analogous to the veſtibulum of the former claſſes[18]. A ſmall bony tube is found on each ſide at the root of the palpi: its external opening is cloſed by a firm membrane; and it contains a membranous lining, on which a nerve ariſing from a common branch with that of antennæ, is expanded. The latter circumſtance might favour an opinion that the antennæ themſelves are organs of hearing: but this is refuted by conſidering the exquiſite ſenſe of hearing, which ſome inſects poſſeſs, who have no true antennæ, as the ſpiders; and by experiments on others, which ſhew that the ſenſe of hearing is not weakened by removing the antennæ [19].

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[17] See the works of LEHMANN and SCHELVER, which I have already often quoted.

[18] P. A. MINASI, *Diſſertations on various of the leſs obvious Facts of Natural Hiſtory*, in Italian. Nap. 1775, 8vo. fig. 4, of the *cancer pagurus*. SCARPA *de auditu*, tab. 4, fig. 4, 5, 6, of the crawfiſh. COMPARETTI, tab. 3, fig. 26-28, of ſeveral other ſpecies. But whether the parts repreſented in the other figures of this table, on the heads of ſeveral inſects, as beetles, butterflies, common flies, &c. are really organs of hearing, is extremely doubtful.

(F) VERMES.

§ 271. In the ſepia only has any thing been hitherto diſcovered at all like an organ of hearing. In the cartilaginous ring, to which the large tentacula of the animal are affixed, two oval cavities appear. In each of theſe is a ſmall bag containing a bony ſubſtance, and receiving the termination of nerves, like thoſe of the veſtibulum in fiſhes [20].

Additional Notes to the Twentieth Chapter.

(A) The cetacea are the only mammalia, which have not a bony external meatus. The tube

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[19] LEHMANN *de Antennis Inſectorum,* diſſert. poſter, p. 45.

[20] SCARPA, *loc. cit.* tab. 4, fig. 7-11. COMPARETTI tab. 3, fig. 10 and 16.

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is cartilaginous in theſe animals, and ſo ſmall that its external orifice will about admit a pin in the dolphin. It arrives at the tympanum after a winding courſe through the fat, which lies under the ſkin. It is probable that the ſound gains admiſſion to the ear in theſe animals, rather through the Euſtachian tube, than through this very narrow meatus externus. That tube opens at the blowing hole, and its furniſhed with a valve that prevents the admiſſion of the water, which the animal expels through this opening.

(B) The following is the paſſage to which the author refers as expreſſing his opinion on this ſubject. I inſert it in this place, becauſe the work in which it is found is not common in this country, and is in the German language. “ Anatomiſts generally deſcribe a fourth bone (the *lenticulus*, or “ *os orbiculare)* as intervening between the long “ leg of the incus, and the head of the ſtapes. “ Repeated and accurate examinations have con- “ vinced me that this part is only an epiphyſis of “ the incus. It is often wanting, even in ſuch oſ- “ ſicula auditus, as appear in other reſpects to be “ of the moſt perfect formation; for inſtance, in “ thoſe of negroes and North American ſa- “ vages, which I have now before me. When it “ exiſts in the adult ſubject, it can only be ſepa- “ rated by the employment of ſome force; and a "microſcopical examination of the ſurfaces ſhews "that the lenticulus has been broken from the incus. "Sometimes, indeed, I have found a really ſeparate "oſſiculum between the incus and ſtapes; but this "cannot, in my opinion, be conſidered as belonging "to the ordinary natural ſtructure, any more "than thoſe other ſupernumerary oſſicula, which "are found not infrequently, both in man and "animals." *Beſchreibung der Knochen*, p. 144.

(C) CUVIER deſcribes a portion of bone as paſſing between the crura of the ſtapes, from one ſide of the feneſtra ovalis to the other, in the mole, and marmot (in which laſt animal it is of conſiderable ſize). (*Léçons d'Anat. comp.* p. 489, tom. 2). Mr. CARLISLE has repreſented this part in the marmot, and he ſtates its exiſtence likewiſe in the guinea pig. (*Philoſ. Tranſ.* 1805, pt. 2).

CUVIER has alſo found that the ſtapes is nearly ſolid in the cetacea; and that there is no perforation in the walrus. This peculiarity of ſtructure ſeems to belong to ſuch mammalia as live in water; for the ſeal has it in a ſmaller degree. *Léçons d'Anat. comp.* tom. 2, p. 505. CARLISLE, *loc. citat.* gives drawings of the ſtapes in theſe animals.

The ſecond oſſiculum of the ornithorhynchus approaches very much in its form to the ſingle bone of birds. (CARLISLE, *loc. cit.*).

(D) The membranous canals and veſtibulum of the amphibia and fiſhes, are much ſmaller than the bony or cartilaginous cavities, in which they reſide. Hence theſe parts can be diſcerned and demonſtrated much more eaſily in theſe animals than in mammalia and birds, where they are cloſely ſurrounded by the bone.

CHAPTER XXI.

ON THE EYE.

§ 272. A SENSIBILITY to the impreſſions of light is common to all thoſe animals, which in a natural ſtate are expoſed to this element: it appears at leaſt very evidently to exiſt in ſome of the moſt ſimple zoophytes, as the armed polypes *(hydra)*: but the power of perceiving the images of external objects is confined to thoſe who are provided with eyes for their reception. Nature has beſtowed on ſome ſpecies even of red-blooded animals, a kind of rudiment of eyes, which have not the power of perceiving light: as if in compliance with ſome general model for the bodily ſtructure of ſuch animals. This circumſtance at leaſt has been aſſerted of the blind rat *(marmota typhlus)* among mammalia; and of the *myxine glutinoſa* among fiſhes.

§ 273. Since the eye[1] is a very complicated organ, particularly in the red-blooded animals, we ſhall firſt ſpeak of thoſe peculiarities, which affect the globe itſelf, its membranes and humours: and afterwards conſider the ſurrounding parts, as the eye-lids, lacrymal paſſages, &c. For ſome general obſervations on the ſituation and formation of the eye-balls, &c. ſee note (A) at the end of the chapter.

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[1] See BIDLOO *de Oculis et Viſu variorum Animalium*, Lugd. Bat. 1715-4. ZINN *de Differentiâ Fabricæ Oculi Humani et Brutorum*, in the *Comment. Societ. Reg. Scient. Gotting.* tom. 4, 1754, p. 191; and in the *Comment.* an. 1778, p. 47.

(A) Mammalia.

§ 274. It has been long known[2], that the ſclerotica, in ſeveral quadrupeds of this claſs, as in the human ſubject, is not throughout of equal ſtrength; but that its poſterior is much thicker than its anterior part. It has alſo been conjectured, that this ſtructure might influence what are called the *internal changes of the eye:* by which the form of the eyeball, conſequently the length of its axis, and the reſpective ſituation of the lens, are adjuſted according to the proximity or remoteneſs of the object, or in reference to any other relations. I flatter myſelf, that I have aſcertained the truth of this conjec-

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W. Porterfield *on the Eye*, Edinb. 1759, 2 vol. 8vo.

Haller in the *Opera minora*, tom. 3, p. 218. J. L. Angely *de Oculis, Organis que Lacrymalibus, Ratione Ætatis, Sexus, Gentis, et variorum Animalium*, Erlang. 1803, 8vo.

[2] Zinn in the *Comment. Soc. Reg. Scient. Gotting.* tom. 4, p. 192.

ture, by diſcovering the admirable ſtructure of the ſclerotica in warm-blooded quadrupeds, which have not only the power of ſeeing at various diſtances, but alſo in two media of ſuch different denſity as air and water. In the eye of the Greenland ſeal, where I firſt noticed the fact[3], the cornea was thin and yielding; the anterior ſegment of the ſclerotica, or that which is immediately behind the latter membrane, was thick and firm; its middle circle thin and flexible; and laſtly, the poſterior part very thick, and almoſt cartilaginous. The whole eye-ball is ſurrounded with very ſtrong muſcles; and we can eaſily underſtand how their action, varied according to circumſtances, produces the requiſite changes; how the axis of the eye is ſhortened, when the animal ſees in air, by bringing the lens nearer to the back of the globe, in order to obviate the ſtrong refraction, which the rays of light experience in paſſing from the thin medium of air into the thicker one of the eyes, and vice verſâ.

The ſclerotica of the cetacea is diſtinguiſhed by the great thickneſs of its poſterior part; when the eye-ball equals an orange in ſize, the back of this membrane is an inch thick; ſo that, although the globe be ſpherical, the ſpace containing the vitreus humor is of a different form. As the ſclerotica approaches to the cornea, it becomes thinner. Its poſterior part preſents a very ſingular ſtructure, conſiſting of very firm tendinous threads and laminæ, moſt cloſely interwoven, and of more than cartilaginous hardneſs[4] towards the ſides.

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[3] *Comment. Soc. Reg.* vol. 7, an. 1784. Dr. Albers has diſcovered the ſame circumſtances in the eye of the Walrus *(trichecus roſmarus)*: and has refuted thoſe objections, which have been made to the aſſigned object of this ſtructure, from the obſervation of ſome ſlight reſemblance to it in the eyes of certain land animals, as the horſe, &c. See the *Gottingen Literary Notices*, 1803, p. 601.

The extent of the cornea, when compared to that of the ſclerotica, varies in the different ſpecies of mammalia. It ſeems to be greateſt in the porcupine *(hyſtrix criſtata)*, where the cornea extends over half the globe.

§ 275. A peculiar ſtructure, which appears hitherto to be unique, has been lately diſcovered in the eye of the Eaſt-Indian rhinoceros. Four tendinous faſciculi ariſe from the back of the ſclerotica, and expand anteriorly, ſo as to join and form a kind of muſcular membrane, which is loſt in the choroid at the broadeſt diameter of the globe[5]. This is probably connected with the internal changes of the organ.

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[4] Ruysch, *Theſaur. Anatom.* 2, tab. 1, fig. 1, 2, 6.

Loder, *Tabulæ Anatomicæ*, vol. 1, tab. 56, fig. 8.

On the eye of the whale in general, ſee Albini, *Index Supellectilis*, J. J. Ravii, p. 36: Alſo his *Annot. Acad.* lib. 7, p. 40, and *Supellex Anatomica*, p. 132.

Muſei Gaubiani Pars complectens preparata Anatomica, p. 14.

[5] Thomas in the *Philoſ. Tranſ.* 1801, pt. 1, p. 149, tab. 10; and Voigt's *new Magazine*, vol. 4, p. 240, tab. 4.

The choroid coat conſiſts more plainly in the cetacea, than in any other mammalia, of two diſtinct laminæ; of which the internal *(membrana ruyſchiana)* is covered with a dull tapetum.

§ 276. The inner ſurface of the choroid coat poſſeſſes, towards the back of the eye, in ſeveral general of this claſs, particularly in thoſe carnivorous animals, which prey by night, and even in the biſulca, the moſt brilliant yellow-green and ſapphire-blue colours; forming what is called the *tapetum lucidum*[6]. The coloured portion of the choroid is only partial, and the reſt of the membrane is covered with pigmentum nigrum, as uſual[7].

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[6] Linn, *loco citato*, p. 196.

H. F. Elsæsser, *de Pigmento Oculi nigro, deque Tapeto*, Tubing. 1800, 8vo.

[7] It is well known that this pigment is entirely, or for the greateſt part deficient in the eye of the *albinos* or *chacrelas*: which ſtrange variety occurs, not infrequently, in the human race, and in ſeveral other mammalia and birds. I know, however, no inſtance of an albino among cold-blooded animals. This anomalous deficiency is always congenital, and is connected with a want of the colouring principle of the ſkin, and of the hair and feathers. It is hereditary in ſome mammalia, ſo as to form a conſtant breed of white animals: viz. in the rabbit, mouſe, and horſe (which latter are thoſe called *glaſſ-eyed*). I cannot believe that any whole ſpecies of warm-

In conſequence of this ſtructure, leſs light will be abſorbed; and it muſt, on the contrary, be reflected from the tapetum againſt the retina, which lies in front of that membrane. (See note (B) at the end of the chapter.)

§ 277. The *retina* exhibits in ſome quadrupeds, viz. the hare and rabbit, very diſtinct and elegant fibres or ſtriæ of medullary ſubſtance, taking for the moſt part a tranſverſe direction[8]. The remarkable *foramen centrale*, which SÖMMERRING diſcovered in the human retina, has been ſince demonſtrated in the eyes of ſeveral quadrumana, where theſe organs are directed forwards, and have their axes parallel[9].

§ 278.

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warm-blooded animals ſhould originally want this pigment, and therefore I conſider the ferret *(muſtela furo)* to have deſcended from the polecat *(m. putorius)*. I have treated at greater length on the want of this pigment, which is ſo eſſential a part in the natural ſtructure of the eye, in the *Comment. Soc. Reg. Scient.* vol. 7, p. 29; and in the third edition of my work, *de Generis Humani Varietate Nativâ*, p. 272.

[8] ZINN, *loco citat.* tab. 8, fig. 3. FONTANA *ſur le Vênin de la Vipére*, vol. 2, tab. 5, fig. 12.

[9] I have found it, for inſtance, very plain in the eye of the common Barbary ape *(ſimia ſylvanus)*. The entrance of the optic nerve formed a ſmall *yellow circle* on the retina: near this a larger *grey fold* appeared, with the *foramen centrale* in its middle.

In demonſtrating lately this opening in the eye of a *ſimia cyno-*

§ 278. The iris, an organ of very peculiar ſtructure, exhibits in the different genera and ſpecies of mammalia more numerous and intereſting varieties than any other part of the eye. The colours of its anterior ſurface, which are peculiar to the different genera, vary in the races and varieties of domeſtic animals, although leſs ſtrikingly than in the human ſubject. Theſe variations are connected, as in the latter inſtance, with the colour of the hair; ſo that in ſpotted dogs, rabbits, &c. a mixture of colours will be ſeen in the iris.

The ſubſtance of the part varies in thickneſs in the different genera. In no inſtance have I hitherto been able to diſcover true muſcular fibres; the examination of the part in the elephant and whale having afforded in this reſpect the ſame reſult, as

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cynomolgus, I advanced the following conjecture as to its uſe. Man, and ſuch animals as have the two eyes placed with their axes parallel, thereby gain the advantage of ſeeing objects with both eyes at once, and therefore more acutely But at the ſame time they are expoſed to this inconvenience that in a ſtrong light both eyes become dazzled at once; and this happens ſo much the ſooner becauſe the light falls on the correſponding principal focuſes of both eyes at once; the organ not poſſeſſing a *membrana nictitans*. This inconvenience ſeems to be obviated by the *foramen centrale*; ſince that part which forms the principal focus of the eye, opens in a dazzling light, ſo as to form a kind of ſmall pupil, through which the concentrated rays paſs, and fall on the choroid, where they are abſorbed by the black pigment.

the tender and almoſt tranſparent iris of the white rabbit.

In the eye of the ſeal the ciliary veſſels are not diſtributed in the ſubſtance of the iris; but lie on its anterior ſurface, and form a conſiderable plexus, which is viſible without any injection [10].

The pupil in the biſulca, ſolidungula, cetacea, &c. is tranſverſe; in animals of the cat kind, particularly in a clear light, it is oblong: not to mention other trivial peculiarities, as the ſmall villous appendix, covered with pigmentum nigrum [11], which is ſometimes ſeen on the middle of the ſuperior margin of the pupil, particularly in the horſe [12]. (See note (C) at the end of the chapter.)

§ 279. The corpus ciliare, and particularly the folds of its internal ſurface, with their numerous and elegantly arranged blood-veſſels, conſtitutes one of the moſt wonderful parts of the eye, although its functions, which muſt undoubtedly be of the higheſt importance, are hitherto involved in myſtery. Its more minute differences in the genera, which have been hitherto examined, are too numerous to be recounted; and they could not be underſtood without delineations[13]. Among other inſtances, thoſe of the elephant and horſe may be mentioned, on account of the remarkable beauty and delicacy of their ſtructure.

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[10] *Comment. Soc. Reg. Scient. Goetting. loco citato*, fig. 2, 3.

[11] This part has a brown colour, in the eye of a white horſe, which is in my collection; while the other parts of the ſame eye, which in horſes in general are black, have only a ſlight greyiſh brown tinge.

[12] SWAMMERDAM, in ſpeaking of the remarkable curtain of the pupil, which is found in the ſkate, ſays he has diſcovered a ſimilar part in the horſe. If he does not allude to any unuſual formation, but merely to ſuch appendices as I have mentioned, the compariſon is certainly too far fetched. *Biblia Naturæ*, p. 881.

§ 280. The ſize of the *cryſtalline lens* varies in proportion to that of the *vitreous humor;* and ſome times very conſiderably. I have found the largeſt lens in this point of view in the comparatively ſmall eye of the opoſſum *(didelphis marſupialis)*; the whale has the ſmalleſt. No mammalia have it ſo ſlightly convex on the ſurface as the adult man. In the cat, hare, the biſulca, the horſe, opoſſum, and ſeal, it becomes more and more convex according to the ſeries, in which I have named theſe animals. Laſtly, in the cetacea it is nearly ſpherical[14]. (See note (D).

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[13] Much information may be gained on this ſubject from JAC. HOVIUS *de Circulari Humorum Motu in Oculis.* ed. 2, Lugd. Bat. 1716, 8vo. This work, however, is in ſome parts unintelligible, and not to be depended on; and muſt, therefore, be conſulted with caution.

[14] F. P. DU PETIT in the *Mem. de l'Acad. des Sciences,* 1730. The memoir is tranſlated in FRORIEP'S *Bibliotheca for comparative Anatomy,* in German, vol. 1, p. 209.

It is curious to obſerve the regularity, with which, in ſome ſpecies, the lens divides into certain ſegments commencing from its centre, in conſequence of being dried or immerſed in acids[15].

§ 281. A *lacrymal gland*[16] exiſts in all animals of this claſs. Several quadrupeds have, indeed, an additional one, beſides that which is found in the human ſubject. Some have no *puncta lacrymalia*; and the elephant has neither *lacrymal bag* nor *os unguis*[17]. (See note (E).

§ 282. The nictitating membrane (*membrana nictitans*, *palpebra tertia*, ſeu *interna*, *periophthalmium*), of which only a rudiment exiſts in the quadrumana, and the human ſubject, is very large and moveable in ſome quadrupeds[18]. This is the caſe in animals of the cat kind, in the opoſſum, the ſeal, and particularly in the elephant.

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[15] Leewenhoeck, *Arcana Naturæ detecta*. p. 73.

Perrault, *Hiſtoire des Animaux*, pt. 1, tab. 30.

Young in the *Philoſ. Tranſ.* 1793, tab. 20. Hosack *Philoſ. Tranſ.* 1794, tab. 17. J. C. Reil *de Lentis Cryſtallinæ Structura Fibroſâ*. Halle, 1794, 8vo.

[16] Bertin in the *Mem. de l'Acad. des Sciences*, 1766, p. 281.

[17] Camper, *Œuvres*, tom. 2, p. 138, where he alſo ſtates that this animal has no lacrymal gland, nor paſſage for the tears into the noſe.

[18] Tabarrani in the *Tranſactions of the Academy at Siena*, tom. 3, p. 115.

§ 283.

§ 283. The relative magnitude of the true eye-lids varies conſiderably in animals of this claſs. The lower, which is very large in the elephant, is equally ſmall in the horſe. In the latter animal, as well as in moſt quadrudeds, it has no cilia; while in the quadrumana, the elephant, the giraffe, and others, both eye-lids poſſeſs eye-laſhes.

(B) Birds.

§ 284. The eyes are very large in this claſs of animals [19], and conſequently the bony orbits are of great magnitude in proportion to the ſkull.

In the birds of prey they have a peculiar form, which is ſimilar to that of the chalice, or cup uſed in the communion ſervice: the cornea, which is very convex, forms the bottom of the cup; and the the poſterior ſegment of the ſclerotica reſembles its cover [20].

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[19] Beſides the works, which have been referred to above, (§ 273) ſee the memoirs of Petit on this ſubject in the *Mem. de l'Acad. des Sciences*, an. 1726, 1735, and 1736. Home in the *Philoſ. Tranſ.* 1796, which is tranſlated into German, in Reil's *Archives*, vol. 2, pt. 2. Albers's *Contributions*, vol. 1, p. 69.

[20] Severini, *Zootomia Democritea*, p. 336.

Em. König in the *Ephem. Natur. Curioſ.* Dec. 2, an. 4, obſ. 34.

§ 285. This peculiar form ariſes from the curvature and length of the bony plates, which, as in all other birds[1], occupy the front of the ſclerotica; lying cloſe together, and overlapping each other. Theſe bony plates form in general a flat, or ſlightly convex ring; being long and curved in the accipitres, they form a concave ring, which gives the whole eye-ball the above-mentioned form[2].

§ 286. The diſtinction between certain parts of the eye, where the membranes have been ſuppoſed to be continuous, appears more plainly in ſome birds, than in any other animals. Thus I have found the boundaries of the choroid coat and iris very clearly defined in the horned owl *(ſtrix bubo)*: and thoſe of the margin of the retina, and the poſterior border of the ciliary body very diſtinct in the toucan *(ramphaſtos tucanus)*. (See note (F).

§ 287. A great peculiarity in the eye of birds conſiſts in the *marſupium*[3] *(pecten plicatum*, in

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[1] Coiter, *Miſcell. Obſerv. Anat. Chirurg.* p, 130.

Pierce Smith in the *Philoſ. Tranſ.* 1795, pt. 2, p. 263.

[2] Dr. Albers obſerves that the orbit is very imperfect in birds; and that this bony ring may ſupply the deficiency, *loco citato*.

[3] See a neat delineation of the internal parts of the eye in the oſprey *(falco oſſifragus)* by D. G. Kieser, *de Anamorphoſi*

French, *la bourſe, le peigne)*, the uſe of which has not been hitherto very clearly aſcertained. It ariſes in the back of the eye, proceeding apparently through a ſlit in the retina; it paſſes obliquely into the vitreous humor, and terminates in that part, reaching in ſome ſpecies to the capſule of the lens. The figure of its circumference is a truncated quadrangle. Numerous blood-veſſels run in the folds of membrane which compoſe it; and the black pigment by which it is covered, ſuggeſts an idea that it is chiefly deſtined for the abſorption of the rays of light, when they are too ſtrong or dazzling.

§ 288. Birds have large lacrymal paſſages, which terminate on the ſurface of the palate[4].

Their nictitating membrane[5] is furniſhed with two very manifeſt muſcles[6]. (See note (G).

In ſome ſpecies, as the common fowl, the turkey, gooſe, and duck, the lower eye-lid, which contains

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phoſi Oculi, Goetting, 1804, 4to, tab. 2, fig. 1. The whole diſſertation contains much inſtructive matter on this ſubject.

[4] MONRO, *Obſervations Anatomical and Phyſiological.* Edinb. 1758, 8vo. Albers, *loco citato.* fig. 1, 2.

[5] It is called by the emperor FREDERIC II. *pellicula palpebrarum.*

[6] PETIT in the *Mem. de l'Acad. des Sciences,* 1735, and 1736.

a peculiar ſmall lamina of cartilage, is the moſt moveable; in others on the contrary, as in the parrots, and oſtrich, the upper has the moſt extenſive motion.

Very few birds have cilia in both eye-lids: they are found in the oſtrich, the *falco ſerpentarius*, the razor-billed blackbird *(crotophaga ani)* and in ſome parrots. (See note (G).

(C) AMPHIBIA.

§ 289. Little is hitherto known concerning the peculiarities in the ſtructure of the eye of this claſs[7].

In ſome reptiles and ſerpents of this country, the common integuments form, inſtead of eye-lids, a kind of firm window, behind which the eye-ball has a free motion.

In the green turtle[8] *(teſtudo mydas)* the ſclerotica has a bony ring at its anterior part, compoſed like that of birds, of thin oſſeous plates. Theſe animals poſſeſs very large lacrymal glands, and a very moveable membrana nictitans; in which circumſtance the frog reſembles them[9]. (See note (H).

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[7] PETIT in the *Mem. de l'Acad. des Sciences*, 1737 p. 142.

[8] Dr. ALBERS intends to publiſh an accurate account of the anatomy of the eye in this animal.

[9] CALDESI, *Obſervations concerning the Turtle*, tab. 8, fig. 11.

§. 290.

(D) FISHES.

§ 290. The peculiarities in the eye of fiſhes[10], which belong either to the whole claſs, or to moſt of the genera and ſpecies, conſiſt in the diviſion of their choroid coat and retina into ſeveral manifeſtly diſtinct laminæ; and in the exiſtence of two ſmall organs within the eye, which belong excluſively to this claſs.

§ 291. The choroid coat, which in man is a ſimple membrane, and in ſome other warm-blooded animals, particularly in the cetacea, a double one, conſiſts in fiſhes of three diſtinct laminæ. The inner layer forms a true *tunica ruyſchiana*; the middle one (*membrana vaſculoſa* of HALLER), is perfectly diſtinct both from the former, and from the exterior coat; which latter muſt be compared with the proper choroid of all red-blooded animals. Even this laſt is continued anteriorly into the iris, and poſſeſſes in many ſpecies the well known brilliant gold and ſilver colours.

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[10] Good delineations of the internal ſtructure of the eye of fiſhes are ſtill wanting. The beſt, which I know of, are by GUENELLON, of the cod's eye; but they are contained in a book, where one ſhould not much expect to find them, viz. in BAYLE's *Nouvelles de la Republique des Lettres*, March, 1686, p. 326.

The retina is eaſily ſeparable into two laminæ; of which the external is medullary, and the internal conſiſts of a fibrous texture.

§ 292. The two other peculiarities belong excluſively to the eye of fiſhes; and are common at leaſt to the whole bony diviſion of theſe animals. A body, generally reſembling in ſhape a horſe-ſhoe, lies between the internal and middle layers of the choroid; ſome have thought it muſcular, and others glandular. The tunica ruyſchiana gives origin to a vaſcular membrane, reſembling in its form a bell (*campanula* of HALLER). This goes towards the lens, and has, therefore, ſome reſemblance to the marſupium of birds.

No true ciliary body is found, at leaſt in the bony fiſhes.

§ 293. The cryſtalline lens of moſt fiſhes is very large in compariſon with the ſize of the eyeball, and nearly or entirely ſpherical. The *vitreous humour* on the contrary is ſmall, and the *aqueus* in many caſes is hardly diſcernible.

§ 294. The following may be enumerated as inſtances of remarkable peculiarities in the eyes of particular genera and ſpecies of fiſhes. The firm tranſparent laminæ of common integuments, behind which the eye-balls move, as in ſome amphibia[12] (§ 289); the articulation of the globe on a ſtalk of cartilage in the ſkate, and ſhark[13]: the curtain (*operculum pupillare*) in the eye of the ſkate[14], which can be let down ſo as to cover the pupil: and the unique ſtructure of the *lobitis anableps*, where the cornea is divided into two portions, and there is a double pupil with a ſingle lens[15]. (See note (I).

(E) INSECTS.

§ 295. Two kinds of eyes, very diſſimilar in their ſtructure, are found in this claſs[16]. One ſort is ſmall and ſimple (*ſtemmata*): the others, which are large, ſeem to conſiſt of an aggregation of ſmaller eyes[17]; for their general convexity is divided into an immenſe number of ſmall hexagonal convex ſurfaces, which may be conſidered as ſo many diſtinct corneæ. The firſt kind is formed in different numbers in moſt of the aptera, as alſo in the larvæ of many winged inſects. When theſe undergo the laſt or complete metamorphoſis, and receive their wings, they gain at the ſame time the large compound eyes. Several genera of winged inſects, and aptera (as the larger ſpecies of monoculi[18]) have ſtemmata beſides their compound eyes.

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[12] *Delineations of Objects in Natural Hiſtory*, pt. 6, where the part is repreſented in the *oſtracion bicuſpis*.

[13] STENONIS, *Specimen Elementor. Myologiæ*, tab. 5, fig. 1. GOYEAU in the *Mercure de France*, Dec. 1757, p. 130.

[14] STENONIS *de Muſculis et Glandulis*, p. 68. CAMPER in the *Mémoires préſentés a l'Acad. des Sciences des Paris*, tom. 6, tab. 3, fig. 1.

[15] SEBA *Theſaur. Rer. Natural*, tom. 3, tab. 34.

CAMPER in the German tranſlation of MONRO's *Phyſiol. of Fiſhes*, p. 165.

LACEPEDE in the *Mem. de l'Inſtitut. National*, tom. 2, p. 372.

[16] LEHMANN and SCHELVER, *locis citatis*.

[17] HOOKE's *Micrographia Reſtaurata*, tab. 20, 21.

§ 296. The internal ſtructure has hitherto been inveſtigated only in the large polyedrous eyes[19]. The back of the cornea (which is the part, divided in front into the hexagonal ſurfaces, called in French, *facettes*) is covered with a dark pigment. Behind this are numerous white bodies, of an hexagonal priſmatic ſhape, and equal in number to that of the facettes of the cornea. A ſecond coloured membrane covers theſe, and appears to receive the expanſion of the optic nerve.

§ 297. Further inveſtigation is, however, required in order to ſhew how theſe eyes enable the inſect to ſee; and to determine the diſtinctions between two ſuch very different organs [20].

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[18] ANDRE in the *Philoſ. Tranſ.* vol. 72, pt. 2, of the *Monoculus Polyphemus*.

[19] SWAMMERDAM, tab. 20, has repreſented the ſtructure of the eye in the drone or male bee.

CUVIER in the *Mem. de la Societé d'Hiſt. Nat. de Paris*, an. 7, p. 41, fig. 3, that of the dragon-fly *(libellula grandis)*.

(F) VERMES.

§ 298. The cuttleſiſh only, of this whole claſs [1], has been hitherto ſhewn to poſſeſs true eyes; the nature of which cannot be diſputed. They reſemble on the whole thoſe of red-blooded animals, particularly fiſhes; they are at leaſt incomparably more like them than the eyes of any known inſects; yet they are diſtinguiſhed by ſeveral extraordinary peculiarities [2]. The front of the eye-ball is covered with looſe membranes inſtead of a cornea; the iris is compoſed of a firm ſubſtance, which ſeems like a continuation of the ſclerotica; and a proceſs projects from the upper margin of the pupil, which gives that membrane a ſemilunar form.

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[20] I have given, on a former occaſion, the reaſons, which led me to think it probable, in oppoſition to the general opinion formerly maintained; that the polyedrous eyes are adapted for diſtant objects, and the ſimple ones for ſuch as are more near. This is confirmed by obſerving, that butterflies, which, in their perfect or winged ſtate, have the large compound eyes, have only the myopic organs while larvæ.

Yet there are ſtill ſome doubts reſpecting the uſes of theſe two kinds of eyes; for ſome complete *animalia ſubterranea*, as the *gryllus gryllotalpa* have both kinds.

[1] LEHMANN and SCHELVER, *loc. citat.*

[2] SWAMMERDAM, tab. 52, fig. 2.

The corpus ciliare is very completely formed.

In all other vermes the eyes are entirely wanting, or their exiſtence is very doubtful. Whether the black points, at the extremities of what are called the horns of the common ſnail[3], are organs which really poſſeſs the power of viſion, is ſtill problematical[4].

Additional Notes to the Twenty-firſt Chapter.

(A) Large animals have ſmall eye-balls in proportion to their ſize: this is very remarkably the caſe with the whales. Thoſe which are much under ground have the globe alſo very ſmall; as the mole and ſhrew: in the former of theſe inſtances its exiſtence has been altogether denied; and it is not in fact larger than a pin's head.

The eyes of man and the ſimiæ are directed forwards: in the latter animals indeed they are placed nearer to each other than in the human ſubject. The *lemur tarſius* has them more cloſely approximated than any other animal. All other mammalia have theſe organs ſeparated by a conſiderable interval, and directed laterally. The ſame circumſtance obtains in birds with the exception of the owl, who looks ſtraight forwards. They are placed laterally in all reptiles: Their ſituation varies much in fiſhes: they look upwards in the uranoſcopus: they are both on the ſame ſide of the body in the pleuronectes: but in general their direction is lateral.

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[3] Ibid. tab. 4, fig. 7, 8.

[4] LEHMANN, p. 44.
SLEVOGT in VOIGT'S *Magazine*, vol. 6, p. 466.

The form of the globe varies according to the medium, in which the organ is to be exerted. In man and the mammalia, it deviates very little from the ſpherical figure. In fiſhes it is flattened on its anterior part; in birds it is remarkably convex in front, the cornea being ſometimes abſolutely hemiſpherical. The convexity of the cryſtalline is in an inverſe ratio to that of the cornea. Thus in fiſhes it is nearly ſpherical, and projects through the iris, ſo as to leave little or no room for aqueus humor: the cetacea, and thoſe quadrupeds and birds, which are much under water, have this part of the ſame form. The aqueus humor being of the ſame denſity with the medium in which theſe animals are placed, would have no power of refracting rays of light, which come through that medium: its place is ſupplied by an encreaſed ſphericity of the lens. In birds theſe circumſtances are reverſed: they inhabit generally a ſomewhat elevated region of the atmoſphere; and the rays, which paſs through this thin medium are refracted by the aqueus humor, which exiſts in great abundance. Man and the mammalia, which live on the ſurface of the earth, hold a middle place between theſe two extremes.

(B) The tapetum occupies the temporal ſide of the bottom of the eye-ball; i. e. it is placed exteriorly to the entrance of the optic nerve. It exiſts in the carnivorous and ruminating animals; in the ſolipeda, pachydermata, and cetacea. In the dog, wolf, and badger, it is of a pure white, bordered by blue.

(C) The figure of the pupil is tranſverſely oblong in the ruminating animals, and the horſe: it is heart-ſhaped in the dolphin.

(D) The cryſtalline is ſmaller in the eye of man than in any animal, and it is largeſt in the fiſhes.

The following numbers give the proportions of the three humours, meaſured on the axis of the eye, after it had been frozen.

	Aqueus Humor.	Cryſtalline.	Vitreus Humor.
Man,	$\frac{5}{22}$	$\frac{4}{22}$	$\frac{15}{22}$
Dog,	$\frac{5}{21}$	$\frac{8}{21}$	$\frac{8}{21}$
Cow,	$\frac{5}{37}$	$\frac{14}{37}$	$\frac{18}{37}$
Sheep,	$\frac{4}{17}$	$\frac{11}{17}$	$\frac{12}{17}$
Horſe,	$\frac{9}{43}$	$\frac{16}{43}$	$\frac{18}{43}$
Owl,	$\frac{8}{27}$	$\frac{11}{27}$	$\frac{8}{27}$
Herring,	$\frac{1}{7}$	$\frac{5}{7}$	$\frac{1}{7}$

The greater convexity, which the author aſcribes to the ſeal and whales, ariſes from their inhabiting the water; ſo that they require an organ of viſion like that of fiſhes.

(E) In addition to the lacrymal gland, ſeveral mammalia have another body, called the *glandula Harderi*. This is ſituated nearer to the noſe, and pours out a thick whitiſh fluid near the third eye-lid. It joins the proper lacrymal gland in the hare and rabbit; but is diſtinguiſhed by its whiter colour. The ruminantia, carnivora, and pachydermata, have it likewiſe.

The ducts of the lacrymal gland admit of very eaſy demonſtration in the larger quadrupeds, where they open to the number of ſixteen or more, by orifices that will admit a large briſtle.

The hare and rabbit have, inſtead of puncta lacrymalia, a ſlit opening into the lacrymal canal.

The cetacea want the lacrymal apparatus entirely, as their eyes are preſerved in a moiſt ſtate by the element in which they live.

The muſcles of the eye-ball are the ſame in number in the ſimiæ as in man: but other mammalia poſſeſs an additional one, termed the *ſuſpenſorius oculi*.

This muſcle is of a conical form. Its origin, which takes place from the margin of the optic foramen, repreſents the apex of the cone; and its inſertion into the poſterior half of the ſclerotica, conſtitutes the baſis. It fills up therefore the interval left between the four recti, and ſurrounds completely the optic nerve. In ſeveral of the carnivora, and the cetacea, it is divided into four portions; ſo that theſe animals may be ſaid to have eight ſtraight muſcles. It muſt enable the animals which poſſeſs it to draw the globe back into the orbit; and hence it has ſometimes been called the *retractor* of the eye.

A remarkable peculiarity occurs in the conjunctiva of the zemni *(mus typhlus)*. It is covered with hair as in other parts of the body, ſo that the eye, which is, indeed, exceedingly ſmall, ſeems to be completely uſeleſs. A ſimilar ſtructure is alſo found in two fiſhes, the murena cecilia, and myxine glutinoſa *(Gaſtrobranchus cæcus*, CUVIER). *Leçons d'Anat. comp.* tom. 2, p. 394.

(F) The ciliary proceſſes of birds are not very prominent: they conſiſt rather of ſtriæ, than of looſe folds. They are always cloſely connected to the cryſtalline capſule. There is no tapetum in this claſs.

The colour of the iris varies in the different ſpecies of birds; and in many inſtances poſſeſſes great brilliancy. It has a power of voluntary motion in the parrot.

The retina paſſes obliquely through the ſclerotica, in a ſheath of the latter membrane.

(G) Birds poſſeſs both a lacrymal gland, and glandula Harderi. The latter is conſiderably the largeſt; and is uſually placed between the elevator and adductor muſcles of the globe. It furniſhes a thick yellow fluid, which is poured from a ſingle duct, opening on the inner ſurface of third eye-lid.

The eye-lids are cloſed in moſt birds by the elevation of the inferior palpebra, which is the largeſt. This eye-lid has a peculiar depreſſor muſcle ariſing from the bottom of the orbit. The owl, and the goatſucker are among the few in which the upper eye-lid deſcends.

The third eye-lid, or *membrana nictitans* is a thin ſemitranſparent fold of the conjunctiva; which, in the ſtate of reſt, lies in the inner corner of the eye, with its looſe edge nearly vertical, but can be drawn out ſo as to cover the whole front of the globe. By this, according to CUVIER, the eagle is enabled to look at the ſun.

It is capable of being expanded over the globe of the eye by the combined action of two very ſingular muſcles, which are attached towards the back of the ſclerotica. One of theſe, which is called from its ſhape the *quadratus*, ariſes from the upper and back part of the ſclerotica; its fibres deſcend in a parallel courſe towards the optic nerve, and terminate in a ſemicircular margin, formed by a tendon of a very ſingular conſtruction: for it has no inſertion, but conſtitutes a cylindrical canal. The ſecond muſcle, which is called the *pyramidalis*, ariſes from the lower and back part of the ſclerotica towards the noſe. It gives riſe to a long tendinous chord, which runs through the canal of the quadratus, as in a pulley. Having thus arrived at the exterior part of the eye-ball, it runs in a cellular ſheath of the ſclerotica along the under part of the eye, to the lower portion of the looſe edge of the *membrana nictitans*, in which it is inſerted.

By the united action of theſe two muſcles, the third eye-lid will be drawn towards the outer angle of the eye, ſo as to cover the front of the globe; and its own elaſticity will reſtore it to its former ſituation.

(H) The ciliary proceſſes are hardly perceptible in the turtle; but they leave an elegant inpreſſion on the ſurface of the vitreous humor. They are diſtinct and long in the crocodile. The blood-veſſels are viſible on the ſurface of the iris; where they form a diſtinct plexus in the crocodile.

The optic nerve forms a tubercle within the ſclerotica; from which the retina commences.

The number, &c. of the eye-lids varies conſiderably in this claſs. Serpents have none. The turtle and crocrodile have three like thoſe of birds. The frog and toad have three; of which the third is much the largeſt and moſt moveable.

The turtle has a very large lobulated lacrymal gland. Serpents have nothing of this kind.

(I) The continuation of the conjunctiva over the cornea admits of being demonſtrated in the eel. For it comes off ſome times with the reſt of the ſkin of the head in ſtripping off he integuments of this animal,

CHAPTER XXII.

ON THE MUSCLES.

§ 299. THE heart and other muſcular viſcera have been already treated of. We have only to ſpeak here of the proper muſcles, which are deſtined to the performance of the voluntary motions. As the details of myology do not come within the plan of this work, the preſent chapter will include only a few remarks on the peculiarities in the muſcular ſtructure of the different claſſes, and of ſome particularly remarkable ſpecies[1].

(A) MAMMALIA.

§ 300. The degree of reſemblance between the muſcles of the mammalia[2], and thoſe of the human ſubject, may be inferred, in any particular inſtance, by comparing the ſkeleton of the animal with that of man. The ſimilarity is greateſt, on the whole, in the quadrumana. Yet theſe are diſtinguiſhed by the ſmallneſs of their buttock and calf of the leg; the ſtrength and convexity of which parts conſtitute peculiar beauties in the human form[3]. (See note (A) at the end of the chapter.)

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[1] It can be hardly neceſſary for me to ſtate that the 1ſt vol. of CUVIER's excellent work contains by far the moſt complete account, that we hitherto poſſeſs, of comparative myology in general: and that numerous remarks on the ſubject may be found in BORELLI *de Motu Animalium*, and in BARTHEZ *Nouvelle Mechanique des Mouvements de l' Homme et des Animaux*. Carcaſſone, 1798, 4to.

[2] We have excellent accounts of the myology of particular ſpecies of this claſs: as for inſtance, of the chimpanſé (*ſimia troglo-*

§ 301. Of the muſcles which do not exiſt in man, nor as far as we hitherto know, in the quadrumana; but which on the contrary are found at leaſt in the greateſt number of quadrupeds[4]; the cutaneous expanſion of the trunk *(panniculus carnoſus, expanſio carnea, muſculus ſubcutaneus)*, and the *ſuſ-*

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troglodytes) by TYSON: of the dog, by DOUGLAS, in his *Specimen Myographiæ comparatæ*; and by GARENGEOT, in the *Myotomie Humaine et Canine.* Paris, 1724, 8vo: of the horſe, by STUBBS, in his unrivalled "*Anatomy of the Horſe*": of the cow, by VITET *Medecine Veterinaire*, vol. 1.

[3] ARISTOTLE *de Partibus Animalium*, 4, 10.

[4] It does not exiſt in the pig; but is of extraordinary ſtrength in ſuch animals, as have the power of rolling themſelves up; as the tatu, (armadillo) manis, porcupine, hedgehog, &c. See the excellent monograph of HIMLY, *on the rolling up of the hedgehog.* Brunſwick, 1801, 4to.

The tendinous fibres of this cutaneous expanſion may be ſplit into threads of a hundred feet or more in length in the cetacea; and the inhabitants of the Aleutian iſlands prepare in this way a very delicate kind of thread.

penſorius oculi[5] deſerve particular mention. (For the particular deſcription of the latter muſcle, ſee the chapter on the eye.)

§ 302. Among ſuch, on the contrary, as are found only in particular genera and ſpecies, the moſt remarkable are the extremely numerous muſcles of the prehenſile tails of ſome cercopitheci (ſapajous, belonging to the *ſimiæ* of LINNÆUS), and other South American and Auſtralaſian mammalia[6]; thoſe which we have already deſcribed in the trunk of the elephant[7]; and that which belongs to the epiglottis of ſeveral mammalia *(cerato-epiglottidæus)*[8].

§ 303. Other muſcles, which are common to moſt orders of the claſs, are diſtinguiſhed in ſome ſpecies by remarkable ſtrength, which adapts them for peculiar kinds of motion. This is the caſe with the *gluteus medius*[9] of the horſe; which, in connection with ſome others, particularly the *gemellus*[10], enables the animal to kick out backwards with ſuch aſtoniſhing force; with the immenſely ſtrong flexors of the beaver's tail, &c. (See note (B).

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[5] ZINN *in Comment. Soc. Reg. Scient.* Gotting. tom. 1, p. 48.

[6] MERY reckoned no leſs than 280 muſcles in the prehenſile tail of a cercopithecus. DU HAMEL, *Hiſt. Acad. Reg. Scient.* p. 276.

[7] See the intereſting obſervations of CUVIER on the organization of the elephant's trunk, in the ſeventh part of the *Menagerie du Muſeum National.* He deſigns to explain the wonderful ſtructure of this completely unique organ, in a ſeparate work, with twelve plates. Some remarks on the ſubject may be found in the valuable *Deſcription Anatomique d'un Elephant male, par* P. CAMPER, *publieé par ſon Fils,* A. G. CAMPER, Paris, 1802, folio.

[8] J. G. RUNGE *de Voce ejuſque Organis,* Lugd. Bat. 1753, 4to.

(B) BIRDS.

§ 304. The muſcles in this claſs are diſtinguiſhed by poſſeſſing a comparatively weak irritable power, which is ſoon loſt after death; and by their tendons becoming oſſified, as the animal grows old, particularly in the extremities, but ſometimes alſo in the trunk. I have obſerved this to a very remarkable degree, in the crane[11].

§ 305. The moſt remarkable circumſtances in the myology of this claſs[12] have been incidentally mentioned in previous parts of the work. For inſtance, muſcles which are peculiar to birds; as thoſe of the membrana nictitans *; or ſuch as are deficient, as the diaphragm; or diſtinguiſhed by their remarkable ſize and peculiar form, as the pectoral muſcles †.

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[9] STUBBS *Muſcles*, tab. 2, q, Q, r, s, t; and tab. 3, a, b, c, d.

[10] Ibid. tab. 3, 60—64.

[11] This appearance led ſeveral phyſiologiſts of the 17th century to the erroneous concluſion, that the bones in general, at leaſt for the moſt part, are formed from tendons. See STENONIS *de Muſculis et Glandulis*, p. 26. CASP. BARTHOLIN *Specimen Hiſtoriæ Anatomicæ Partium Corporis Humani*, p. 185.

[12] On the myology of birds the reader may conſult STENONIS

(C) AMPHIBIA.

§ 306. The two chief diviſions of this claſs are diſtinguiſhed from each other by a remarkable difference in their muſcular ſtructure, which ariſes from a correſponding diverſity in the ſkeleton. In the reptiles, for inſtance, and particularly in the turtles [13] and frogs, where the trunk of the ſkeleton poſſeſſes but little mobility, the muſcles are very few in number. Not only the diaphragm, but alſo the muſcles

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NONIS in the *Act. Havniens*, 1673, p. 6; and VALENTINI *Amphitheat. Zootom.* pt 2, p. 8.

Alſo VICQ-D'AZYR in the *Mem. de l'Acad. des Sciences de Paris*, 1772. MERREM'S *Miſcellaneous Tracts in Natural Hiſtory*, p. 144.

And WIEDEMANN'S *Archives*, vol. 2, p. 68.

* Theſe muſcles are deſcribed in the chapter, which treats on the eye.

† For a more particular deſcription of theſe muſcles, ſee note (C) at the end of the chapter: and for the mechaniſm by which birds are ſupported in rooſting, note (D).

[13] For the myology of this animal ſee WIEDEMANN'S *Archives*, vol. 3, pt. 2, p. 78.

muſcles of the abdomen and cheſt are wanting in the genus teſtudo. The other muſcles are, however, of vaſt ſtrength in this genus. In the ſerpents on the contrary, they are more uniform and thin; and more numerous beyond all compariſon, in conſequence of the vaſt number of vertebræ and ribs, and the want of all external organs of motion.

(D) FISHES.

§ 307. The muſcles of this claſs[14] are diſtinguiſhed from thoſe of animals which breathe by means of lungs, not only by receiving a ſmaller ſupply of blood, and conſequently being of a paler colour; but alſo by their diſpoſition in layers, and by the uniformity[15] of their ſubſtance, which in general is deſtitute of tendinous fibres. This ſtructure, together with the number and bulk of their muſcles, is well calculated to ſupport that great expenditure of ſtrength and exertion, which is a neceſſary conſequence of the peculiar abode, and whole economy of theſe animals[16].

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[14] LACEPEDE, *Hiſt. Naturelle des Poiſſons*, tom. 1, *Diſcours*, p. 47.

[15] KIELMEYER *on the Relation of the Organic Powers to each other*, p. 22, 8vo, 1793, Stutgard.

[16] Dr. BLANE's *Lecture on Muſcular Motion*, p. 54.

(E) INSECTS.

§ 308. The obſervations which have juſt been made concerning the uniformity, number, and ſtrength of the muſcles of fiſhes, will hold equally good, on the whole, of inſects; but under other modifications, and generally in a more ſtriking degree[17]. In the few, which have been hitherto inveſtigated with a view to this ſubject, ſome differences have been obſerved. The immenſely ſtrong muſcles of the claw in the crab and lobſter[18], bear conſiderable analogy to thoſe in ſome organs of red-blooded animals: while the muſcles of other inſects, as may be ſeen in the larvæ, are diſtinguiſhed by a peculiar bluiſh white colour, and flattened form. Their great number concurs alſo with theſe characters in diſtinguiſhing them from thoſe of the former claſſes. LYONET[19] reckoned 4061 in the larva of the coſſus[20]: and 2186 of theſe belong to the alimentary canal.

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[17] KIELMEYER, *loco citato.*

[18] STENONIS *Specimen Elementorum Myologiæ*, p. 55. PERRAULT *Eſſais de Phiſiqne*, tom. 3, tab. 4, fig. 3.

[19] Tab. 6, 7, 8, 15, 16, 17; and tab. 5, fig. 7, 8.

[20] This number includes about ten times as many as belong to the human body.

(F) VER-

(F) VERMES.

§ 309. The arrangement of the muſcular ſyſtem of the molluſca[1] has conſiderable analogy, on the whole, to that of the larvæ of inſects. Thoſe which inhabit ſhells, have, moreover, peculiar muſcles connecting them to their teſtaceous covering, and enabling them to move it. Thus the ſnail has large muſcular faſciculi running along the abdomen, attaching it to the upper turn of the ſhell, and enabling the animal to withdraw itſelf into the cavity. The bivalves have powerful adductor muſcles to cloſe their ſhells[2]. In ſeveral of the *molluſca nuda* there is a conſiderable apparatus of cutaneous fibres, by which a very remarkable ſhortening of the body can be produced. A ſimilar and very aſtoniſhing contractile power reſides in the gelatinous parenchyma of the zoophytes, and animals which inhabit corals; in whoſe ſtructure nothing like muſcular fibres can be diſtinguiſhed.

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[1] See an account of the muſcles of the *Aphrodite aculeata*, in PALLAS's *Miſcellanea Zoologica*, tab. 7, fig. 13.

Of the *Tritonia*, *Aplyſia*, &c. by CUVIER, in the *Annales du Muſéum National d' Hiſt. Nat.* tom. 1 and 2.

Of the ſnail *(helix pomatia)* by SWAMMERDAM, tab. 6, fig. 2, of numerous bivalves and multivalves in ſeveral figures of POLI's work.

[2] HUNTER *on the Blood*, p. 111. POLI, vol. 1, *Introduction*, p. 59.

Addi-

Additional Notes to the Twenty-ſecond Chapter.

(A) The differences which we diſcern in the muſcles of the lower extremity between man and the other mammalia, ariſe out of that characteriſtic feature, which ſo ſtrikingly diſtinguiſhes man from all other animals: viz. his erect ſtature. The moſt minute inveſtigation of this ſubject will ſhew us that the erect poſition belongs to man only; and thereby confirms the elegant obſervation of the Roman poet:

> Pronaque cum ſpectent animalia cetera terram,
> Os homini ſublime dedit; cœlumque tueri
> Juſſit; et erectos ad ſidera tollere vultus.

In order to enable any animal to preſerve the erect poſition, the following conditions are required. Firſt, That the parts of the body ſhould be ſo diſpoſed, as to admit of being maintained with eaſe in a ſtate of equilibrium; 2dly, That the muſcles ſhould have ſufficient power to correct the deviations from this ſtate; 3dly, That the centre of gravity of the whole body ſhould fall within the ſpace occupied by the feet; and laſtly, That the feet themſelves ſhould have a broad ſurface reſting firmly on the ground, and ſhould admit of being in a manner fixed to the earth. All theſe circumſtances are united in the neceſſary degree in man only.

The broader the ſurface included by the feet, the more ſecurely will the line of gravity reſt within that ſurface. The feet of man are much broader than thoſe of any animal, and admit of being ſeparated more widely from each other. The ſources of the latter prerogative reſide in the ſuperior breadth of the human pelvis, and in the length and obliquity of the neck of the femur, which by throwing the body of the bone outwards, diſengage it from the hip-joint.

The whole tarſus, metatarſus, and toes, reſt on the ground in the human ſubject, but not in other animals. The ſimiæ, and the bear, have the end of the os calcis raiſed from the ſurface; while on the contrary it projects in man, and its prominent portion has a moſt important ſhare in ſupporting the back of the foot. The exterior margin of the foot reſts chiefly on the ground in the ſimiæ; which circumſtance leaves them a freer uſe of their thumb and long toes in ſeizing the branches of trees, &c.; and renders the organ ſo much the leſs adapted to ſupport the body on level ground.

The *plantaris* muſcle, inſtead of terminating in the os calcis, expands into the plantar faſcia in the ſimiæ; and in other quadrupeds it holds the place of the *flexor brevis* or *perforatus digitorum pedis*, paſſing over the os calcis in ſuch a direction that its tendon would be compreſſed, and its action impeded if the heel reſted on the ground.

The extenſors of the ancle joint, and chiefly thoſe, which from the calf of the leg, are very ſmall in the mammalia, even in the genus ſimia. The peculiar mode of progreſſion of the human ſubject ſufficiently accounts for their vaſtly ſuperior magnitude in man. By elevating the os calcis they raiſe the whole body in the act of progreſſion; and, by extending the leg on the foot, they counteract that tendency, which the weight of the body has to bend the leg in ſtanding.

The thigh is placed in the ſame line with the trunk in man; it always forms an angle with the ſpine in animals; and this is often even an acute one. The extenſors of the knee are much ſtronger in the human ſubject than in other mammalia, as their double effect of extending the leg on the thigh, and of bringing the thigh forwards on the leg forms a very eſſential part in the human mode of progreſſion.

The flexors of the knee are, on the contrary, ſtronger in animals; and are inſerted ſo much lower down in the tibia (even in the ſimiæ), than in the human ſubject, that the ſupport of the body on the hind legs muſt be very inſecure; as the thigh and leg form an angle, inſtead of continuing in a ſtraight line.

The *gluteus maximus*, which is the largeſt muſcle of the human body, is ſo ſmall and inſignificant in animals, that it may almoſt be ſaid not to exiſt. This muſcle, which forms the great bulk of the human buttock, extends the pelvis on the thighs in ſtanding; and, aſſiſted by the other two *glutei*, maintains that part in a ſtate of equilibrium on the lower extremity, which reſts on the ground, while the other is carried forwards, in progreſſion. The true office of theſe important muſcles does not therefore conſiſt, as it is uſually repreſented, in the common anatomical works, in moving the thigh on the pelvis, but in that of fixing the pelvis on the thighs, and of maintaining it in the erect poſition.

Such then are the ſupports, by which the trunk of the human body is firmly maintained in the erect poſition. The properties of the trunk, which contribute to the ſame end, do not ſo immediately belong to the preſent part of the work; but may be ſlightly mentioned to complete the view of the ſubject. The breadth of the human pelvis affords a firm baſis on which all the ſuperior parts reſt ſecurely; the ſame part is ſo narrow in other animals, that the trunk repreſents an inverted pyramid; and there muſt conſequently be great difficulty in maintaining it in a ſtate of equilibrium, if it were poſſible for the animal to aſſume the erect poſition. In thoſe inſtances, where the pelvis is broader, the other conditions of the upright ſtature are abſent: the bear, however, forms an exception to this obſervation, and conſequently admits of being taught to ſtand and walk erect, although the poſture is manifeſtly inconvenient and irkſome to the animal.

The perpendicular poſition of the vertebral column under the centre of the baſis cranii, and the direction of the eyes and mouth forwards would be as inconvenient to man, if he went on all-fours; as they are well adapted to his erect ſtature. In the former caſe he would not be able to look before him; and the great weight of the head, with the comparative weakneſs of the extenſor muſcles, and the want of ligamentum nuchæ would render the elevation of that organ almoſt impoſſible.

When quadrupeds endeavour to ſupport themſelves on the hind extremities, as, for inſtance, for the purpoſe of ſeizing any objects with the fore-feet, they rather ſit down than aſſume the erect poſition. For they reſt on the thighs as well as on the feet, and this can only be done where the fore-part of the body is ſmall, as in the ſimiæ, the ſquirrel, &c.: in other caſes, the animal is obliged alſo to ſupport itſelf by the fore-feet, as in the dog, cat, &c. The large and ſtrong tail in ſome inſtances forms as it were a third foot, and thereby increaſes the ſurface for ſupporting the body; as in the kanguroo and the jerboa.

Various gradations may be obſerved in the mammalia, connecting man to thoſe animals which are ſtrictly quadrupeds. The ſimiæ, which are by no means calculated for the erect poſition, are not, on the other hand, deſtined like the proper quadrupeds to go on all-fours. They live in trees, where their front and hind extremities are both employed in climbing, &c.

The true quadrupeds have the front of the trunk ſupported by the anterior extremities, which are conſequently much larger and ſtronger than in man; as the hind-feet of the ſame animals yield in theſe reſpects to thoſe of the human ſubject. The cheſt is in a manner ſuſpended between the ſcapulæ, and the *ſerrati magni* muſcles which ſupport it in this poſition are conſequently of great bulk and ſtrength. When viewed together they repreſent a kind of girth ſurrounding the cheſt.

(B) The *pectoralis major*, *latiſſimus dorſi*, and *teres major*, are of vaſt ſize in the mole; and enable the animal to dig its way under ground, and to throw up the earth.

(C) Birds poſſeſs three pectoral muſcles, ariſing chiefly from their enormous ſternum, and acting on the head of the humerus. The firſt, or *great pectoral*, weighs, of itſelf, more than all the other muſcles of the bird together. The keel of the ſternum, the fork, and the laſt ribs, give origin to it; and it is inſerted in a rough projecting line of the humerus. By depreſſing that bone, it produces the ſtrong and violent motions of the wing, which carry the body forwards in flying. The *middle pectoral* lies under this; and ſends its tendon over the junction of the fork, with the clavicle and ſcapula, as in a pulley, to be inſerted in the upper part of the humerus; which bone it elevates. By this contrivance of the pulley, the elevator of the wing is placed at the under ſurface of the body. The third, or *leſſer pectoral* muſcle, has the ſame effect with the great pectoral, in depreſſing the wing.

(D) One of the flexor tendons of the toes of birds, (produced from a muſcle which comes from the pubis) runs in front of the knee; and all theſe tendons go behind the heel: hence the flexion of the knee and heel produces mechanically a bent ſtate of the toes, which may be ſeen in the dead bird; and it is by means of this ſtructure that the bird is ſupported, when rooſting, without any muſcular action.

"This circumſtance of the flexion of the toes accompanying that of the other joints of the lower extremity of birds, was long ago obſerved by BORELLI, and attributed by him to the connexion, which the flexors of the toes have with the upper parts of the limb, by which they are mechanically ſtretched, when the knee is bent. This explanation has been controverted by VICQ D' AZYR, and others, who have referred the effect to the irritability of the muſcles. The opinion of BORELLI appears, notwithſtanding, to be well founded; for not only the tendon of the acceſſory flexor paſſing round the knee, but the courſe of the flexor tendons over the heel, and along the metatarſus, muſt neceſſarily cauſe the contraction of the toes, when either of theſe joints is bent; and if the phenomenon was not produced on mechanic principles, it would be impoſſible for birds to exhibit it during ſleep, which they do, or to prove the effect on the limb of a dead bird, than which nothing is more eaſy. The utility of this contrivance is great in all birds, but particularly ſo in the rapacious tribe, which by this means graſp their prey in the very act of pouncing on it; and it is ſtill more neceſſary to thoſe birds which perch or rooſt during their ſleep, as they could not otherwiſe preſerve their poſition, when all their voluntary powers are ſuſpended."

REES'S *Cyclopedia*, art. BIRDS.

THE

GENERATIVE FUNCTIONS.

CHAPTER XXIII.*

ON THE MALE ORGANS OF GENERATION.

§ 310. IN conſidering the comparative anatomy of the ſexual functions, we muſt confine ourſelves to thoſe animals, which poſſeſs male organs deſtined for the purpoſe of impregnation, and female parts for that of conception.

To the former belong chiefly the teſtes, veſiculæ ſeminales, proſtate and penis. Yet the three laſt mentioned parts, and particularly the veſiculæ and proſtate are by no means conſtantly found even in red-blooded animals.

§ 311. The teſtes, and ſometimes the veſiculæ ſeminales and proſtate vary moſt remarkably in their magnitude in ſuch animals, as have a regular rutting ſeaſon. They are very diminutive at other periods of the year; but ſwell at that particular time to a comparatively vaſt magnitude. This change is particularly obſervable in the teſtes of the mole, ſparrow, and frog[1].

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* For a general account of this ſubject, ſee note (A) at the end of the chapter.

[1] In animals, which have loſt the teſtes by the operation of

§ 312. It is neceſſary to mention here, in a curſory and general manner, the peculiar organs poſſeſſed by the males of ſome ſpecies, for the purpoſe of holding the female during the act of copulation. Of this kind are, the ſpur on the hind-feet of the male ornithorhynchus; the rough black tubercle formed in the ſpring ſeaſon on the thumb of the common frog; the two members, formed of bones articulated to each other, near the genitals of the male torpedo and other cartilaginous fiſhes[2]; the forceps on the abdomen of the male dragon-fly, &c.

(A) MAMMALIA.

§ 313. A *ſcrotum*, or bag, in which the teſtes hang on the outſide of the abdominal cavity exiſts only in the mammalia; but is not by any means common to all the genera. It is not found, and that for very obvious reaſons, in the aquatic animals of this claſs; nor in the perfect *ſubterranea* (thoſe

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of caſtration, a ſimilar circumſtance may be obſerved in ſome of the remaining organs; as in the veſiculæ ſeminales of the gelding. BOURGELAT, *Elémens de l'Art Veterinaire.* Paris, 1769, 8vo. p. 359.

[2] RAY, KLEIN, BATTARRA and others, conſidered theſe parts as real organs of generation: and the ſame miſtake was committed by MENZ and KRÜGER concerning the tubercles on the thumb of the frog.

which live under ground), as the mole; nor in ſuch as roll themſelves up on the approach of danger, as the hedgehog. Theſe which may be called true *teſticonda* (i. e. animals having their teſtes concealed) muſt be diſtinguiſhed from ſuch, as have the power of withdrawing theſe glands from the abdomen, and retracting them into the cavity according to circumſtances; as the hamſter [3] *(marmota cricetus)* and Canadian muſk-rat [4] *(mus zibethicus)*.

In thoſe *teſticonda*, which have the penis much concealed by the integuments in its unerected ſtate, as the hare, rabbit, elephant, &c. it is difficult ſome times to diſtinguiſh the ſexes on the firſt view, particularly at an early age. (For further particulars reſpecting the poſition of the teſtes, &c. ſee note (B) at the end of the chapter.)

§ 314. In ſeveral quadrupeds, as the dog, horſe, ram and others, there is a body, compoſed of condenſed cellular ſubſtance, lying according to the axis of the teſticle near the epididymis, and known by the name of *corpus Highmori*. This is not a canal, nor does it poſſeſs that artificial ſtructure which has been been deſcribed and delineated by ſeveral anatomiſts of the ſeventeenth century[5]. (See note (C).

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[3] SULZER, p. 38, 67.

[4] SARRAZIN in the *Mem. de l'Acad. des Sciences de Paris*; 1725.

§ 315. Moſt ſpecies of mammalia, and, with the exception of the cetacea[6], ſome out of every other order in the claſs, poſſeſs *veſiculæ ſeminales*. They ſwell to a vaſt ſize in the rutting ſeaſon in many animals, as ſome of the ſimiæ, and moſt particularly in the hedgehog[7].

Among the ſpecies, in which theſe parts do not exiſt, are the dog and cat-kind, the bears, the opoſſums, ſea-otter, ſeals, and ornithorhynchus. (For further particulars on this ſubject, ſee note (D).

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[5] De Graaf *de Viror. Organis Generat. inſervient.* tab. 3, fig. 4, in the dog.

See alſo the excellent delineations by A. Monro, junior, *de Teſtibus*, Edinb. 1755, 8vo. tab. 4, fig. 5, in the dog; fig. 8, in the horſe; tab 3, fig. 5, in the pig, &c.

[6] Mr. Hunter at leaſt expreſsly aſſerts, that theſe parts are not found in the cetacea (*Philoſ. Tranſ.* vol. 77, p. 442). I am, indeed, aware of the common opinion, which ſuppoſes the firſt diſcovery of theſe important parts to have been made in the dolphin, by that excellent zootomiſt Rondelet, to whoſe labours the ſcience is ſo much indebted. But the paſſage quoted for this purpoſe from his claſſical work *de Piſcibus Marinis*, p. 461, ſeems to me to be quite as inadequate to prove that point, as the obſervation of Ray on the male organs of the porpoiſe. (*Philoſ. Tranſ.* vol. 6.) which has alſo been applied by Haller to the veſiculæ ſeminales.

[7] Daubenton, vol. 8, tab. 7 and 8.

§ 316.

§ 316. The poſſeſſion of a proſtate (in ſome inſtances ſimple, but generally divided into two parts) is peculiar to the mammalia; and ſeems to take place in every ſpecies of the whole claſs. In many animals, at leaſt, where its exiſtence has been denied, as in the goat and ram, conſiderable glandular bodies are found, which bear a greater reſemblance to the proſtate, than to COWPER's glands[8].

§ 317. In many ſpecies the penis conſiſts of a ſingle *corpus cavernoſum*, without any ſeptum. The pig and the cetacea furniſh examples of this ſtructure; and in the latter animals there are numerous tendinous layers croſſing it[9].

In ſome ſpecies, where the act of copulation requires a longer portion of time, as in the dog, badger, &c. the corpus ſpongioſum of the glans, and of the poſterior part of the penis, ſwells during the act much more conſiderably than the reſt of the organ, and thus the male and female are held together during a ſufficient ſpace of time for the diſcharge of the ſeminal fluid[10]. (See note (E).

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[8] HALLER in *Comment. Soc. Reg. Scient. Gotting.* tom. I, tab. I.

[9] RUYSCH, *Epiſt. Problemat.* 15, tab. 19, fig. 5.

[10] DAUBENTON, tom. 5, tab. 47; and WALTER, *Mêmoire ſur le Blaireau* in the *Mem. de l'Acad. de Berlin*, 1792, p. 20.

§ 318. Several ſpecies of mammalia, both among thoſe, which poſſeſs no veſiculæ ſeminales, and thereby require a longer time for completing the act of copulation, and in ſuch as are not diſtinguiſhed by this peculiarity [11], poſſeſs a peculiar bone in the penis, generally of a cylindrical form, but ſometimes grooved [12]. This the caſe with ſome of the ſimiæ, moſt of the bat-kind, the hamſter and ſeveral others of the mouſe-kind, the dog, bear, badger, weaſel, ſeal, walrus, &c [13].

§ 319. In moſt of the male animals of this claſs the urethra runs on to the end of the glans, and forms a common paſſage for the urine, proſtatic liquor and ſemen. In ſome few ſpecies, the paſſage which conducts the two former fluids, is diſtinct from that of the ſeminal liquor. The bifid fork-like glans of the opoſſum [14] has three openings, one at the point of bifurcation for tranſmitting the urine; and two for the ſeminal fluid at the two extremities of the glans. The ſhort urethra of the *ornithorhynchus paradoxus* opens directly into the cloaca, and the large penis of the animal ſerves merely to conduct the ſeminal fluid. It divides into two parts at its extremity, and each of theſe is furniſhed with ſharp papillæ, which are perforated for the paſſage of the ſemen [15]. A ſimilar ſtructure obtains in the *ornith. hyſtrix*; where the penis divides into four *glandes* [16].

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[11] A *Simia Cynomolgus*, which I lately diſſected, had a ſmall *os penis*, with large veſiculæ ſeminales.

[12] Delineations of this bone in ſeveral ſpecies of animals may be ſeen in REDI *de Viventibus intra Viventia*, tab. 26, and in the works of MEYER and DAUBENTON.

[13] It is ſomewhat remarkable that this bone ſhould not be found in all the ſpecies of the ſame genus. Thus it is wanting in ſeveral ſimiæ, in ſome bats, and in the hyena of the dog-kind. See J. F. HERMANN, *Obſervat. ex Oſteol. comparat.* Argent, 1792, p. 13.

[14] COWPER in the *Philoſ. Tranſ.* vol. 24, p. 1583, fig. 2-5. Among other peculiarities of this ſingular animal, it may be mentioned, that the penis lies behind the ſcrotum.

§ 320. In ſome ſpecies of the cat-kind the glans is covered with retroverted papillæ, which, as theſe animals have no veſiculæ ſeminales, may enable the male to hold the female longer in his embraces [17].

§ 321. Laſtly, it deſerves to be mentioned, that in ſome ſpecies of this claſs, the male penis, while unerected, is turned backwards; ſo that the urine is voided in the male, in the ſame direction as in the female. The hare, lion, and camel, afford inſtances of this ſtructure. But the ſtatement which has been ſo often repeated ſince the time of ARISTOTLE[18], that theſe *retromingentia* copulate backwards, is erroneous.

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[15] HOME in the *Philoſ. Tranſ.* 1802, tab. 4, fig. 1.

[16] Ibid. tab. 12, fig. 1.

[17] In a collection at Hanover there is a penis, which muſt have belonged to a tiger, or ſome ſimilar ſpecies; where the lower part of the glans is furniſhed with two ſtrong horny proceſſes divided each into three points, which are turned backwards.

(B) BIRDS.

§ 322. The teſtes, which lie near the kidnies, and the *ductus deferentes*, are the only male organs which are conſtantly found in the whole claſs[19]. (See note (F).

In a very few inſtances, as in the cock, the laſt mentioned canals terminate in a dilated part, which has been conſidered analogous to the veſiculæ ſeminales. Inſtead of a penis, moſt birds have in the cloaca two ſmall papillæ, on which the ſeminal ducts terminate. This is the caſe in the cock[20], turkey, and pigeon.

Some few ſpecies have a ſimple penis of conſiderable length, which is ordinarily concealed and retracted within the cloaca; but remains viſible externally for ſome time after copulation. It forms a long worm-ſhaped tube in the drake[1]; and conſtitutes a groove in the oſtrich, which is viſible when the animal diſcharges its urine[2].

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[18] *Hiſtoria Animalium*, II. 1, V. 2, and *de Partibus Animal*, IV. 10.

[19] G. G. TANNENBERG. *Spicilegium Obſervationum circa Partes Genitales Maſculas Avium.* Goetting. 1789-4.

[20] DE GRAAF, *de Mulierum Organis*, tab. 17. TANNENBERG, tab. 1 and 2.

(C) AMPHIBIA.

§ 323. The kidney, teſtes, and epididymis, lie cloſe together in the teſtudines; but each of the three organs may be diſtinguiſhed by its peculiar colour and ſtructure on the firſt view. They appear to have no veſiculæ ſeminales[3]; I could at leaſt diſcover none in a *teſtudo græca*, which I lately diſſected. The penis on the contrary is very large; and retracted within the cloaca in its ordinary ſtate. Inſtead of an urethra, this part contains a groove; whoſe margins approach to each other, when the part is erected, ſo as to form a cloſed canal [4]. The glans terminates in an obtuſe hook-like point, ſomewhat reſembling the end of the elephant's trunk.

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[1] Ibid. tab. 2 and 3; alſo HOME, *loc. citat.* tab. 12, fig. 2.

[2] CUVIER in the firſt part of the *Ménagerie du Muſeum National.*

[3] I ſhould not expreſs myſelf with uncertainty on this ſubject, if Lieberkuhn had not aſcribed veſiculæ ſeminales to the turtle; (he does not mention the ſpecies); G. E. HAMBERGER, *Phyſiol. Med.* p. 712.

There is much obſcurity in the different deſcriptions of the male organs of generation of the turtle and tortoiſe. The various obſervations on this ſubject are collected by SCHNEIDER in his *Natural Hiſtory of the Genus Teſtudo*, p. 129. See alſo GILIBERT, *Medecin Naturaliſte*, 1ſt ſeries. Lyons, 1800-8, p. 290.

§ 324. Frogs [5] have large veſiculæ ſeminales; and a ſmall papilla in the cloaca, inſtead of a penis. Both theſe parts are wanting in the toad [6].

§ 325. Crocodiles have a ſimple penis; while the lizards of this country have two; and the water-newt, which does not copulate, has no organ of the kind.

§ 326. Serpents have long ſlender teſticles; no veſiculæ ſeminales; but a double penis, each of which has a bifid point covered with ſharp papillæ [7].

(D) FISHES.

§ 327. The male organs of generation poſſeſs very different ſtructures[8] in the different orders of this claſs. We ſhall take two ſpecies as examples; the torpedo for the cartilaginous, and the carp for the bony fiſhes.

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[4] This may be compared with the groove-like continuation of the œſophagus, which goes into the third ſtomach of ruminating animals. (See § 90 and 91).

[5] RÖSEL, tab. 5, fig. 1, 2, and 3, tab. 6, fig. 1.

[6] Ibid. tab. 21, fig. 25 and 26.

[7] TYSON in the *Philoſ. Tranſ.* vol. 13, tab. 1, fig. 2, in the rattleſnake, and fig. 3, in the viper.

In the former inſtance there are manifeſt teſticles, conſiſting partly of innumerable glandular and granular bodies, and partly of a ſubſtance like the ſoft roe of bony fiſhes. We find alſo *vaſa deferentia*, and a veſicula ſeminalis which opens into the rectum by means of a ſmall papilla[9].

The ſoft roe ſupplies the place of teſtes in the carp[10], and moſt other bony fiſhes. It forms two elongated flat viſcera of a white colour, and irregular tuberculated ſurface; placed at the ſides of the inteſtines and ſwimming bladder, ſo that the left encloſes the rectum in a kind of groove. Through the middle of each ſoft roe paſſes a *ductus deferens*, which opens behind into a kind of veſicula ſeminalis, and this terminates in the cloaca[11].

§ 328.

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[8] Ph. Cavolini *on the Generative Proceſs in Fiſhes and Crabs;* with *Remarks by* E. A. W. Zimmermann. Berlin, 1792, 8vo. in German.

De Graaf, *Partium Genitalium Defenſio*, pag. 253.

[9] Lorenzini, tab. 4, fig. 4. See alſo Monro's *Phyſiology of Fiſhes*, tab. 11, 12.

[10] Petit in the *Mem. de l'Acad. des Sc.* 1733, tab. 17.

[11] It is a curious circumſtance, that hermaphrodites, poſſeſſing the complete organs of both ſexes, are found very frequently

(E) INSECTS.

§ 328. The animals of this claſs exhibit ſuch numerous varieties of ſtructure in the different orders, genera, and ſpecies[12], that we ſhall be contented with chooſing two of the latter as examples. Theſe are, the moth of the ſilk-worm (*bombyx mori*), which is choſen becauſe its genital organs reſemble thoſe of ſome of the more perfect red blooded animals; and a ſpecies of locuſt (*gryllus*) on account of the external reſemblance between the male and female organs.

In the latter (*gryllus verrucivorus*) the large teſticles with their convoluted faſciculi of veſſels bear

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quently in this ſpecies: much oftener than among other fiſhes. See ALISCHER in the *Breſlau Collections*, 14 verſ. p. 645. SCHWALBE in the *Commerc. Lit. Noric.* 1734, p. 305. and MORAND in the *Hiſt. de l'Acad. des Sc.* 1737, p. 51.

I poſſeſs the whole viſcera of two ſuch individuals, that were ſent to me within a ſhort time of each other in the laſt year.

According to BONNET fiſhes have ſometimes no ſexual diſtinctions. *Œuvres*, vol. 3, p. 506.

[12] See a repreſentation of theſe parts in the *ſcarabæus naſicornis*, by SWAMMERDAM, tab. 30, in a large water-beetle, tab. 22; in the *nepa cinerea*, tab. 3; in the *papilio urticæ*, tab. 36; in the *ephemera horaria*, tab. 14; in the drone, tab. 21 and 22; in the *muſca cameleon*, tab. 42; in the *muſca putris*, 43.

In a *cicada* MALPIGHI *de Bombyce*, tab. 11, fig. 2.

In a crab, CAVOLINI, tab. 2, fig. 10, 11. In the *cancer Bern-*

bear a very cloſe reſemblance to the ovaries, in which the ova are collected into ſimilar bundles [13].

In the moth of the ſilk-worm we diſtinguiſh, beſides the teſtes, long *vaſa deferentia*, even a kind of veſiculæ ſeminales, and a very conſiderable penis, with a hook-ſhaped glans [14].

(F) VERMES.

§ 329. From this claſs we ſhall ſelect two inſtances [15]. The one is an inteſtinal worm (*aſcaris lumbricoides*), and derives, therefore, ſome intereſt from its connection with noſology. The cuttle-fiſh, of the claſs molluſca, forms the other, and is ſelected on account of the remarkable peculiarities in its male organs.

The aſcaris has one teſtis, occupying nearly the middle of the animal's body, and conſiſting of

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Bernhardus, SWAMMERDAM, tab. 11. In the crawfiſh, RÖSEL, vol. 3, tab. 60.

[13] RÖSEL, vol. 2, tab. 9, of the locuſts.

[14] MALPIGHI, tab. 10, fig. 1. SWAMMERDAM, tab. 28, fig. 3.

[15] For the male organs of ſuch vermes, as have the generative parts of both ſexes combined in each individual. See SWAMMERDAM, tab. 8, fig. 9, where they are repreſented in the ſlug.

For thoſe of the *aplyſiæ, clio borealis*, and *tritonia*. See CUVIER, *loco citato*.

Of the *lepas balanus*, POLI, vol. 1, tab. 4, fig. 13.

Of the *helix pomatia*, SWAMMERDAM, tab. 5, fig. 10.

a ſingle

a ſingle veſſel convoluted into a long bundle, but admitting of being unravelled with facility; when it appears to be about three feet in length. Towards the poſterior part of the worm it forms a larger tube, which nearly equals a crow's quill in ſize, and becomes connected to the penis, which lies concealed near the tail, and is probably projected at the time of copulation[16]. (See note (G).

The male organs of the cuttle-fiſh (*ſepialoligo*) have excited particular attention, from the remarkable, and, indeed, ſomewhat heightened deſcription which TURBERVILLE NEEDHAM[17] gave of them, and which formed the baſis of BUFFON's theory of generation[18].

The part, which correſponds to the ſoft roe of bony fiſhes, contains at the ſpawning ſeaſon ſeveral hundred ſmall tubular ſeminal receptacles (about four lines in length): theſe are placed in bundles towards the vas deferens, and are contained in a thick fluid. Theſe tubes are expelled from the body in an entire ſtate; when a ſpiral veſſel, which they contain, together with the ſemen, as in a ſheath, burſts their thin anterior extremity, from which the ſemen eſcapes and impregnates the ſpawn of the female.

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[16] TYSON in the *Philoſ. Tranſ.* vol. 13, p. 161, fig. 1.

[17] *Nouvelles Obſervations Microſcopiques,* tab. 3 and 4.

[18] *Hiſtoire Naturelle,* tom. 2, p. 230.

Additional Notes to the Twenty-third Chapter.

(A) I have inſerted the following general view of the ſubject of generation from the 5th vol. of the *Leçons d'Anatomie comparée*, as it affords a comparative ſtatement of the manner, in which that function is executed in the different claſſes; although the remarks may be conſidered by ſome as too much of a phyſiological nature to admit of inſertion in a merely anatomical work.

" The nature of *generation*, which is the greateſt myſtery in the economy of living bodies, is ſtill involved in impenetrable obſcurity. The *creation* of a living body, that is, its formation by the union of particles ſuddenly brought together, has not hitherto been proved by any direct obſervation. The compariſon of this proceſs to that of cryſtallization is founded in a falſe analogy: cryſtals are formed of ſimilar particles attracting each other indifferently, and agglutinated by their ſurfaces, which determine the order of their arrangement: living bodies, on the contrary, conſiſt of numerous fibres or laminæ of heterogeneous compoſition, and various figures, each of which has its peculiar ſituation in relation to the other fibres and laminæ. Moreover, from the inſtant in which a living body can be ſaid to exiſt, however ſmall it may be, it poſſeſſes all its parts; it does not grow by the addition of any new laminæ, but by the uniform or irregular development of parts which exiſted before any ſenſible growth.

" The only circumſtance common to all generation, and conſequently the only eſſential part of the proceſs, is, that every living body is attached at firſt to a larger body of the ſame ſpecies with itſelf. It conſtitutes a part of this larger body, and derives nouriſhment, for a certain time, from its juices. The ſubſequent ſeparation conſtitutes *birth*; and may be the ſimple reſult of the life of the larger body, and of the conſequent development of the ſmaller, without the addition of any occaſional action.

" Thus the eſſence of *generation* conſiſts in the appearance of a ſmall organiſed body in or upon ſome part of a larger one; from which it is ſeparated at a certain period in order to aſſume an independent exiſtence.

" All the proceſſes and organs, which co-operate in the buſineſs of generation in certain claſſes, are only acceſſory to this primary function.

" When the function is thus reduced to its moſt ſimple ſtate, it conſtitutes the *gemmiparous*, or *generation by ſhoots*. In this way the buds of trees are developed into branches, from which other trees may be formed. The polypes (*hydra*) and the ſea anemones (*actinia*) multiply in this manner; ſome worms are propagated by a diviſion of their body, and muſt therefore be arranged in the ſame diviſion. This mode of generation requires no diſtinction of ſex, no copulation, nor any particular organ.

" Other modes of generation are accompliſhed in appropriate organs: the germs appear in a definite ſituation in the body, and the aſſiſtance of certain operations is required for their further development. Theſe operations conſtitute *fecundation*, and ſuppoſe the exiſtence of *ſexual parts*; which may either be ſeparate, or united in the ſame individual.

" The office of the male ſex is that of furniſhing the *fecundating* or *ſeminal fluid*: but the manner, in which that contributes to the development of the germ, is not yet ſettled by phyſiologiſts. Some, forming their opinions from the human ſubject and the mammalia, where the germs are imperceptible before fecundation, ſuppoſe that theſe are created by the mixture of the male fluid with that which they ſuppoſe to exiſt in the female; or that they pre-exiſt in the male ſemen, and that the female only furniſhes them with an abode. Others conſult the analogy of the other claſſes of animals, and of plants. In ſeveral inſtances, particularly in the frog, the *germ* may be clearly recogniſed in the *ovum*, before fecundation; its pre-exiſtence may be concluded in other caſes, from the manner in which it is connected to the ovum when it firſt becomes viſible; for it is agreed on all ſides that the ovum exiſts in the female before fecundation,

ſince

ſince virgin hens lay eggs, &c. From ſuch conſiderations theſe phyſiologiſts conclude, that the germ pre-exiſts in all females; and that the fecundating liquor is a ſtimulus which beſtows on it an independent life, by awakening it, in a manner, from the ſpecies of lethargy, in which it would otherwiſe have conſtantly remained.

" The origin of the germs, and the mode of their exiſtence in the female; whether they are formed anew by the action of life, or are pre-exiſtent, and incloſed within each other; or whether they are diſſeminated, and require a concourſe of circumſtances to bring them into a ſituation favourable for their development; are queſtions, which, in the preſent ſtate of our knowledge, it is utterly impoſſible for us to decide. Theſe points have for a long time been agitated by phyſiologiſts; but the diſcuſſion ſeems now to be abandoned by univerſal conſent.

" The combination of the ſexes, and the mode of fecundation are ſubject to great variety. In ſome inſtances they are united in the ſame individual, and the animal impregnates itſelf. The acephalous molluſca, and the echinus exemplify this ſtructure. In others, although the ſexes are united in each individual, an act of copulation is required, in which they both fecundate, and are fecundated. This is the caſe with the gaſteropodous molluſca, and ſeveral worms. In the remainder of the animal kingdom the ſexes belong to different individuals.

" The fecundating liquor is always applied upon, or about the germs. In many caſes the ova are laid before they are touched by the ſemen; as in ſome fiſhes of the bony diviſion, and the cephalopodous molluſca. Here, therefore, impregnation is effected out of the body; as it is alſo in the frog and toad. But in the latter inſtances the male embraces the female, and diſcharges his ſemen in proportion as ſhe voids the eggs. In moſt animals the ſeminal liquor is introduced into the body of the female, and the ova are fecundated before they are diſcharged. This is the caſe in the mammalia, birds, moſt reptiles, and ſome fiſhes; in the hermaphrodite gaſteropodous molluſca, in the cruſtacea, and inſects. The act by which this is accompliſhed, is termed *copulation.*

" In all the laſt mentioned orders ova may be diſcharged without previous copulation, as in the preceding ones. But they receive no further development; nor can they be fecundated when thus voided.

" The effect of a ſingle copulation varies in its degree; it uſually fecundates one generation only; but ſometimes, as in poultry, ſeveral eggs are fecundated; ſtill, however, they only form one generation.

" In a very few inſtances one act of copulation

fecun-

fecundates ſeveral generations, which can propagate their ſpecies without the aid of the male. In the plant-louſe *(aphis)* this has been repeated eight times; and in ſome *monoculi* twelve or fifteen times.

“ When the germ is detached from the ovary, its mode of exiſtence may be more or leſs complete. In moſt animals it is connected, by means of veſſels, to an organiſed maſs, the abſorption of which nouriſhes and developes it until the period of its birth. It derives nothing, therefore, from the body of the mother, from which it is ſeparated by coverings varying in number and ſolidity. The germ, together with its maſs of nouriſhment, and the ſurrounding membranes, conſtitutes an egg, or *ovum*; and the animals which produce their young in this ſtate, are denominated *oviparous*.

“ In moſt of theſe the germ contained in the egg is not developed until that part has quitted the body of the mother, or has been *laid*; whether it be neceſſary that it ſhould be afterwards fecundated, as in many fiſhes; or require only the application of artificial heat for its incubation, as in birds; or that the natural heat of the climate is ſufficient, as in reptiles, inſects, &c. Theſe are ſtrictly *oviparous* animals.

“ The ovum, after being fecundated, and detached from the ovarium, remains in ſome animals within the body of the mother, until the contained germ be developed and hatched. Theſe are *falſe viviparous* animals; or *ovo-viviparous*. The viper, and ſome fiſhes afford inſtances of this proceſs.

" Mammalia alone are truly viviparous animals. Their germ poſſeſſes no proviſion of nouriſhment, but grows by what it derives from the juices of the mother. For this purpoſe it is attached to the internal ſurface of the uterus, and ſometimes, by accident, to other parts, by a kind of root, or infinite ramification of veſſels, called a *placenta*. It is not, therefore, completely ſeparated from the mother by its coverings. It does not come into the world until it can enjoy an independent organic exiſtence. The mammalia cannot, therefore, be ſaid to poſſeſs an *ovum* in the ſenſe which we have aſſigned to that term.

" From the above view of the ſubject, generation may be ſaid to conſiſt of four functions, differing in their importance, and in the number of animals, to which they belong.

" 1ſt, The *production of the germ*, which is a conſtant circumſtance; 2dly, *fecundation*, which belongs only to the ſexual generation; 3dly, *copulation*, which is confined to thoſe ſexual generations, in which fecundation is accompliſhed within the body:

" Laſtly, *uterogeſtation*, which belongs excluſively to viviparous generation." *Leçon* 29, pag. 2, and ſeq.

(B)

(B) A ſcrotum exiſts in all the quadrumana, and in moſt of the carnivora; in animals of the opoſſum kind, which have it in front of the pelvis; in the hare, and gerboa; in moſt of the ruminating genera, and in the ſolidungula.

The teſtes are placed under the ſkin of the perineum in the pachydermata and the civet; or under that of the groin, as in the camel and otter. They paſs from the abdomen into one or the other of theſe ſituations, particularly at the rutting ſeaſon, in the bats, the mole, ſhrew, and hedge-hog; and in ſeveral rodentia, as the rat, guinea-pig, porcupine, beaver, ſquirrel, &c. They remain conſtantly in the abdomen in the ornithorhynchus paradoxus, and hyſtrix, in the elephant, hyrax, the amphibious mammalia, and the cetacea.

The *tunica vaginalis* exiſts conſtantly in the mammalia. As the horizontal poſition of the body obviates the danger of herniæ, the cavity of this covering always communicates by means of a narrow canal with the abdomen, in ſuch animals as have the teſtes remaining conſtantly in the ſcrotum. Where theſe glands occaſionally paſs out of the abdomen, and return again, the communication is very broad and free.

(C) The ſeminal tubes are collected in ſome animals into large faſciculi; as in the baboons, moſt of the large carnivora, the wild boar, and the rhinoceros. It is the union of the ſepta, which divide theſe faſciculi, that conſtitutes the corpus HIGHMORI. In moſt of the rodentia, and particularly in the rat, theſe tubes are large and parallel, and very eaſily ſeparable.

The vaſa deferentia are uſually enlarged in ſize, and aſſume a cellular ſtructure for ſome ſhort diſtance previous to their termination. The ſtructure of this part is the moſt remarkable in the horſe; where "the vas deferens, in paſſing over the bladder, enlarges to the ſize of the human thumb; this amplification extends from its entrance into the urethra to the diſtance of five or ſix inches from that point, where it again becomes of its ordinary diameter.

"The inſide of this enlargement is compoſed of cells, and ſomewhat reſembles in conſtruction the cells of the corpus cavernoſum penis, paſſing in a tranſverſe direction acroſs the tube. In the centre of this enlargement paſſes the ſmall canal of the vas deferens; each cell communicates by one, two, or more ſmall pores with the canal of the vas deferens, and the cells diminiſh as they approach the neck of the bladder, till they are loſt in a ſmooth paſſage entering the urethra.

"What the purpoſe of this ſtructure is, does not appear; it muſt retard the paſſage of the ſemen, and probably adds ſome fluid to it, ſecreted from the cells themſelves." Mr. CLARK in REES's *Cyclopædia*, art. ANATOMY OF THE HORSE.

The cells of this part contain a thick white fluid, which flows out in abundance on compreſſion.

An analogous ſtructure is met with in the ram.

(D) The following animals have no veſiculæ ſeminales according to CUVIER: the plantigrada, except the racoon and hedge-hog; all the carnivora, and marſupial animals; the ruminantia, the ſeals, the cetacea, and the two ſpecies of ornithorhynchus. Their exiſtence or abſence does not ſeem to follow any general law.

Their form and ſtructure vary almoſt infinitely in the different mammalia, where they often terminate in the urethra by a ſeparate opening from that of the vas deferens. This circumſtance, together with the fact of their containing generally a fluid of different appearance and properties from thoſe of the ſemen, and the glandular ſtructure which their coats poſſeſs in many inſtances, militates ſtrongly againſt the opinion, which conſiders theſe veſicles as reſervoirs of the ſemen, and inclines us to ſuppoſe with Mr. HUNTER, that they add a peculiar ſecretion of their own to the fluid which comes from the teſtes.

See Mr. HUNTER's remarks on the veſiculæ ſeminales, in his *Obſervations on certain Parts of the Animal Economy*, p. 27. and ſeq.

In the hedge-hog theſe parts are of a vaſt ſize, much exceeding the volume of the teſtes. They form four or five bodies on each ſide, conſiſting of a ſmall and infinitely convoluted tube, and open ſeparately into the urethra. The rodentia are generally diſtinguiſhed by the great ſize of their veſicles. Theſe parts in the guinea-pig are long, uniform, cylindrical cavities, containing generally a firm cheeſy matter. In the boar they are very large, and of a lobulated ſtructure; a common excretory duct receives the branches from the lobes. In the horſe, they form two large and ſimple membranous bags, opening near the vaſa deferentia, but ſeparately.

(E) In the quadrumana and bats the penis hangs looſe from the pubis as in man. In moſt of the other mammalia it is contained in a ſheath of the integuments, which extends nearly to the navel, This ſheath has an adductor and a retractor muſcle. The penis is generally folded when drawn within the ſheath, on account of its length. In ſome animals it turns back, when it has reached the front of the pubis, and paſſes out near the anus; this is the caſe with the guinea-pig, marmot, and ſquirrel. It goes directly backwards from the beginning in the hare, rat, dormouſe and opoſſum, where the prepuce is found cloſe to the anus.

The corpora cavernoſa form a cylindrical ring in the kanguroo; and the urethra paſſes in the centre.

Mr. B. CLARK has given us the following intereſting obſervations on the penis of the horſe, in his deſcription of the anatomy of that animal in the 2nd vol. of REES's *Cyclopædia*, art. ANATOMY OF THE HORSE.

"We have remarked that the penis of the horſe poſſeſſes a voluntary power of erection, not known to the human, nor perhaps to moſt other animals. This power is exerted on making water, and though the erection is not very conſiderable, it is yet ſufficient to bring the penis from its ſheath, which is effected apparently by its increaſed gravity from blood accumulating in the cavernous cells of this part. After ſtaleing this ſemi-erection of the penis ſubſides, and it is again retracted within the ſheath. This operation, though occurring daily to the ſight of every one, has not, it is apprehended, been noticed by any veterinary writer.

"The urethra of the horſe is muſcular from one extremity to the other, being formed on the outſide of ſtrong tranſverſe fleſhy fibres, and ſupported by a ſtrong ligament.

"In the glans of the penis, immediately over the opening of the urethra, externally, there is a large cell or cavity, ſmooth on the inſide, and lined with a membrane which ſecretes a brown unctuous ſubſtance for the lubrication of the penis, and defending it from the corroſive effects of the urine; another cell of a ſimilar deſcription with the former is obſervable, on the ſide of the urethra, and nearly ſurrounding it; it is ſeparated from the former by a membranous partition.

" The apparently unctuous ſecretion above deſcribed is miſcible with water; it burns, however, in the fire like an oily ſubſtance, and is not ſoluble in ſpirits of wine or nitrous acid, nor does it dry on expoſure to the air during ſeveral weeks.

" There is nothing reſembling a frenum to the penis of the horſe.

" The cavernous body has no longitudinal ſeptum.

" Another ſingularity in the genital parts of this animal is, that there is an immenſe congeries of veins, lying on the back of the penis, which are filled during copulation, forming an elevation nearly as large as the penis itſelf; theſe veins communicate with both the cavernous and ſpongious bodies."

(F) The teſtes of birds conſiſt of a congeries of ſeminal tubes analogous to thoſe of the mammalia.

(G) Dr. Hooper ſtates that he has never found any diſtinction of ſex in theſe worms; but that they all poſſeſs the parts deſcribed as belonging to the female.

See the account compiled by him in the *Mem. of the Lond. Med. Soc.* vol. 5, p. 237. Yet Dr. BAILLIE has given a figure of the male worm, ſimilar to that of TYSON; but it is copied from WERNER. *Faſcic.* 4, pl. 9, fig. 2 and 4. The repreſentation of CUVIER agrees with that of Dr. HOOPER. *Léçons d'Anat. comp.* tom. 5, p. 187.

CHAPTER XXIV.

ON THE FEMALE ORGANS OF GENERATION.

§ 330. AN ovarium * is the moſt eſſential and univerſal of all the female parts of generation. In addition to this, thoſe animals which breathe by means of lungs, as well as ſome fiſhes, and ſeveral white-blooded animals, have alſo *oviducts*, (Fallopian tubes, &c.) or canals leading from the ovarium to the uterus: and laſtly, thoſe, at leaſt, which are impregnated by a real copulation, poſſeſs a *vagina*, or canal connecting the uterus to the external organs of generation.

In birds, all the parts, which we have juſt mentioned, are ſingle. Some cartilaginous fiſhes have two oviducts; beginning, however, by a common opening, and terminating in a ſimple uterus. The human female, as well as that of many other mammalia, has two ovaria, with an oviduct belonging to each; a ſimple uterus, and vagina. The females of this claſs, in ſeveral other inſtances, poſſeſs an *uterus bicornis*: and in ſome caſes the generative organs are double throughout; that is, there are two uteri, and, at leaſt for ſome extent, a double vagina.

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* See note (A) at the end of the chapter.

(A) MAMMALIA.

§ 331. Of the external female ſexual organs in this claſs, the clitoris is found moſt univerſally and invariably[1]; for it exiſts even in the whales[2], and probably is wanting in no other inſtance than the ornithorynchus[3].

As this organ, in its general ſtructure, bears conſiderable reſemblance to the male penis, it contains a ſmall bone in ſeveral ſpecies of mammalia, as the *marmota citillus*, the racoon (*urſus lotor*), the lioneſs, the ſea-otter, &c. In the opoſſum it poſſeſſes a bifid glans, like that of the penis. The analogy between the two organs is carried ſo far in the lori (*lemur tardigradus*), that the urethra runs through the

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[1] LINNEUS conſidered this organ to be a peculiar mark of diſtinction between the human female, and that of the ſimiæ: whereas in the latter animals it is generally remarkably large. I found it of very conſiderable magnitude in a mandrill (*Papio maimon*), which I lately diſſected.

[2] TYSON'S *Anat. of a Porpeſſe*, tab. 2, fig. 3.

In a *balæna boops* of fifty-two feet in length, this part was very large, even in proportion to the monſtrous ſize of the animal.

[3] HOME in the *Philoſ. Tranſ.* 1802, p. 81.

the organ, and terminates on its anterior extremity[4]. In the rat, the domeſtic mouſe, the hamſter, &c. the clitoris and the orifice of the urethra are placed at ſome diſtance from the vagina, and in front of that part. This ſtructure has ſometimes been miſtaken for a preternatural hermaphrodite formation[5]. (See note (B).

§ 332. A true *hymen*, or one at leaſt, which in form and ſituation reſembles that of the human ſubject, has been obſerved in no other animal. The well-known membranous valve, covering the orifice of the meatus urinarius in the vagina of the mare, can by no means be conſidered as a hymen[6] (See note (C).

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[4] AUDEBERT *Hiſt. Nat. des Singes*, tab. 2, fig. 8, of the anatomical figures.

[5] J. J. DÖBEL, in *Nov. Literar. Maris Balthici*, 1698, p. 238.

JO. FABER, in his remarks on F. HERNANDEZ, *Plantar.* &c. *Mexicanar. Hiſtor.* p. 547.

[6] RUINI, p. 164. DAUBENTON, tom. 4, tab. 4, fig. 2; and tab. 8.

BOURGELAT, *loco citato*, p. 383.

BRUGNONE, *Mem. de l' Acad. des Sc. de Turin*, tom. 4, p. 405.

The deſcription of a ſimilar part in the manati of Kamtſchatka *(trichechus manatus)* may be ſeen in the *Nov. Comment. Acad. Petropolitan.* tom. 2, p. 308.

§ 333. The vagina of quadrupeds is diſtinguiſhed from that of the human ſubject by two chief characters: its direction, and the ſtructure of its internal ſurface. In conſequence of the form and poſition of the pelvis, this canal lies in the ſame axis with the uterus, or at leaſt with the neck of that organ. The glandular membrane, which conſtitutes its internal coat, forms none of thoſe extremely elegant tranſverſe plaits, which diſtinguiſh it in the human female, but is merely folded longitudinally. If tranſverſe folds exiſt in any inſtance, they are either confined to the immediate neighbourhood of the external opening, as in the mare; or, if they extend farther, as in the *ſimiæ*, they do not poſſeſs that regular arrangement, or beautiful formation, which are diſplayed in the human female[7].

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[7] A repreſentation of the vagina of the mare laid open, may be ſeen in DAUBENTON, tom. 4, tab. 4, fig. 2.

That of the cow, in NIC. HOBOKEN, *Anat. Secundinæ Vitulinæ*, Ultraject. 1675, 8vo, fig. 3; and in J. G. EBERHARD, *over het verloſſen der Koeijeu*, Amſterdam, 1793, 8vo, tab. 1.

Of the ewe, FAB. AB AQUAPENDENTE, *de formato Fætu*, tab. 17, fig. 35, and 36; and DE GRAAF, *de Mulierum Organis*, tab. 20.

Of the hind, DAUBENTON, tom. 6, tab. 17.

Of the rat, ibid. tom. 7, tab. 38, fig. 3.

Of the genet, *(viverra genetta)* ibid. tom. 9, tab. 37, fig. 2.

Of the panther, ibid. tab. 16.

§ 334. The ſtructure and form of the uterus vary very conſiderably in this claſs. In no inſtance does it poſſeſs that thickneſs, nor has its parenchyma that denſity and toughneſs, which are obſerved in the human female[8]. Of thoſe which I have diſſected, the *ſimia ſylvanus* had comparatively the firmeſt uterus. The two-toed ant-eater came the next in order in this reſpect. But in the greater number of mammalia, this organ is thin in its coats, reſembling an inteſtine in appearance, and provided with a true muſcular covering.

§ 335. The variations in form of the impregnated uterus may be reduced to the following heads:

1. The ſimple uterus without horns *(uterus ſimplex)*, which is generally of a pyramidal or oval figure. This is exemplified in thoſe animals, where we have ſtated that it poſſeſſes thick coats. Its circumference in ſome ſimiæ preſents a more triangular form than in the woman: and towards the upper part, in the neighbourhood of the fallopian

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[8] "The human uterus, ſays Haller, is different from that of all animals which I have diſſected. In quadrupeds this organ is a true muſcle, ſomething like the œſophagus. It is thicker in man, than in any animal." *Element. Phiſiol.* tom. 7, pt. 2, p. 56.

tubes, there is an obſcure diviſion into two blind ſacs[9], (as in the gibbon, or long-armed ape): this diſtinction is more ſtrongly expreſſed in the lori, (*lemur tardigradus*), ſo as to form a manifeſt approach to the *uterus bicornis*[10].

2. A ſimple uterus with ſtraight or convoluted horns (*uterus bicornis*). They are ſtraight in the bitch[11], in the bats of this country, in the ſea-otter, ſeal, &c.[12]: ſomewhat convoluted in the cetacea[13], mare[14], and hedge-hog, and ſtill more tortuous in the biſulca[15].

3. A double uterus, having the appearance of two horns, which open ſeparately into the vagina: this is ſeen in the hare[16] and rabbit[17], (*uterus duplex*).

4. A double uterus, with extraordinary lateral

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[9] Daubenton, tom. 14, tab. 5, fig. 2.

[10] Ibid. tab. 31, fig. 4.

[11] Vesalius, p. 585, ed. of 1555.

[12] Daubenton, tom. 9, tab. 16, of the panther; tab. 33, of the civet; tab. 37, fig. 2, and tab. 38, 39, of the genet; tom. 13, tab. 51, of the ſeal.

[13] Tyson, tab. 2, fig. 3.

[14] La Fosse, tab. 45, 46.

[15] It is repreſented in the ſheep, by De Graaf, tab. 20. In the cow, by Hoboken, fig. 29, 30; by Eberhard, tab. 1.

[16] Daubenton, tom. 6, tab. 45.

[17] De Graaf, tab. 25; Daubenton, *loc. cit.* tab. 56.

convolutions, is met with in the opoſſum and kanguroo[18], *(uterus anfructuoſus)*. (See note (D).

§ 336. Theſe various forms undergo different changes in the pregnant ſtate.

The alteration in the ſimple uterus is, on the whole, analogous to that which occurs in the human female.

The pregnant *uterus bicornis* ſuffers a different change in thoſe animals, which bear only one at a time, from that which it undergoes in the *multipara*. The fetus of the mare is confined in its ſituation to the proper uterus[19]. In the cow it extends at the ſame time into one of the horns, which is enlarged for its reception[20]. In thoſe, on the contrary, which bring forth many young at once, as alſo in the double uterus of the hare and rabbit, both cornua are divided by contracted portions into a number of pouches correſponding to that of the young; and where thoſe horns are ſtraight in the unimpregnated ſtate, as in the bitch, they become convoluted[1].

The

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[18] HOME, in the *Philoſ. Tranſ.* for 1795, tab. 18, fig. 1; tab. 19, fig. 3.

[19] RUINI, pag. 181, et ſeq. FAB. AB. AQUAPENDENTE, tab. 20, 21.

[20] HOBOKEN, fig. 1, 6, 31; EBERHARD, tab. 9, 10.

[1] FAB. AB AQUAPENDENTE, tab. 28, of the bitch.

Id.

The uterus of the opoſſum and kanguroo ſuffers the leaſt change from its uſual appearance in the impregnated ſtate. For theſe ſtrange animals bring their young into the world ſo diſproportionately ſmall, that they appear like early abortions. (See note (E).

§ 337. The *Fallopian tubes* are convoluted upon each other in a kind of knob in ſome inſtances, as the *ſimia ſylvanus*, and ſtill more remarkably in the opoſſum. The *fimbriæ* are ſometimes ſhaped like a funnel, as in the rabbit.

§ 338. The *ovaria* are generally of an oval form, and have the *ovula Graafiana* buried in their parenchyma. Theſe veſicles, however, project externally in ſome caſes, as in the pig; where the ovaries appear tuberculated on the ſurface[2]. In the hedge-hog they are quite looſe and ſeparate, ſo that the ovary reſembles a bunch of grapes, and thereby approaches to the ſtructure of the bird.

The number of veſicles appears to accord on the whole with that of the young, which a mother is capable of producing during her life[3]. And the

corpora

Id. tab. 24, of the pig: alſo Daubenton, tom. 5, tab. 20.
Fab. ab Aquapendente, tab. 29, of the mouſe.
Id. tab. 30, of the guinea-pig.

[2] Wrisberg, in the *Comment. Soc. Reg. Scient. Goetting*, tom. 4, p. 69.

[3] Hunter, in the *Philoſ. Tranſ.* vol. 77, p. 233.

The

corpora lutea, which have received this name from their colour in the ovaries of the cow, are probably never found in the quadruped, except after impregnation[4].

(B) Birds.

§ 339. The female organs of generation in this claſs may be moſt conveniently arranged under three diviſions: The external parts, including the *cloaca*;

The wild and domeſticated races of the ſame ſpecies of animals differ very remarkably in their fertility; which difference furniſhes a new and ſtrong argument againſt the ſuppoſed pre-exiſtence of previouſly formed germs in the female ovary. The domeſtic ſow brings forth commonly two litters in the year, each of which conſiſts, perhaps, of twenty young ones. The wild animal, on the contrary, becomes pregnant only once in the year, and the number of its young never exceeds ten. Both reach about the ſame age; viz. twenty years.

A ſimilar difference is found to obtain between the tame and wild cats; as alſo between the domeſtic dove and the wood-pigeon. How ſhould thoſe domeſtic animals, which deſcend from the original wild ſtock, produce ſuch a remarkably greater number of young ones, if theſe are merely to be evolved from germs, which have exiſted ſince the firſt creation of things?

[4] I have ſhewn in the *Comment. Soc. Goetting.* that corpora lutea may be formed in the ovaria of virgins, as empty *calices* are ſometimes met with in thoſe of birds; and have alſo pointed out under what circumſtances this takes place; tom. 9, p. 109.

the *tubus genitalis* (oviduct) reſembling an inteſtine; and laſtly, the *ovarium*, which is almoſt entirely ſeparate from the latter part.

As the general ſtructure of theſe parts is very uniform in all birds, we may take as an example, the moſt familiarly known ſpecies, the hen[5].

§ 340. The *external* opening of the genitals conſiſts of a *tranſverſe ſlit* behind the oſſa pubis, which do not form a ſymphyſis: this is larger in the hen than in the cock; and its ſmaller anterior labium is covered by the larger poſterior one *(velabrum)*.

This ſlit leads to the cloaca, in which ſeveral organs open, (§ 114). Theſe are the rectum; the two ureters on the prominent margin of that part; the vagina on the left; behind which, and on the upper part of the cloaca, there is the *burſa Fabricii*[6].

§ 341.

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[5] For the ſake of brevity, I refer once for all in this deſcription of the generative organs of birds, to the excellent delineations by Ulmus in Aldrovandi's *Ornitholog*. tom. 2, p. 209, ed. of 1637, and by De Graaf, tab. 18.

[6] The opinion of the celebrated anatomiſt, whoſe name this myſterious organ bears; that it receives and retains the ſemen of the cock, is refuted by this, among other circumſtances; viz. that the part in queſtion is found alſo in the cock, where it is actually much larger than in the hen: nay, it

§ 341. In the *tubus genitalis*, which conſiderably reſembles an inteſtine, and is really on the whole very uniform in its appearance, we may, however, diſtinguiſh three parts. The vagina; the proper *uterus*; and the *oviductus*: the latter part terminates in the *infundibulum*, which is very different in its ſtructure and appearance.

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it is often ſo ſmall in the latter, that its very exiſtence has lately been denied. This, however, is going too far. For I have never failed in finding it, at leaſt in young hens; although it is ſometimes no longer than a barley-corn, and inſtead of being looſe, as in the cock, is cloſely inveſted by cellular ſubſtance, ſo that its demonſtration requires ſome care and attention. The opening, by which it may be inflated, is found on the ſuperior ſurface of the cloaca, behind the termination of the rectum, and on the front edge of a ſmall eminence *(ſcutellum)*, the ſize and development of which ſeem to be in an inverſe ratio to thoſe of the burſa.

From all the obſervations, which I have been able to make on this part (which PERRAULT very inappropriately termed *le troiſieme cæcum)* I am led to conclude, that the function, which forms its final uſe, muſt belong to the male, and that it is only to be conſidered as a mechanical rudiment in the hen, thereby affording another example of the union of the two principles in the *formative impulſe*. (See § 37, and the laſt note but one in that paragraph).

In the preſent inſtance the teleological principle is manifeſted in the burſa of the cock, and the mechanical in that of the hen. In the breaſts, on the contrary, the caſe is reverſed: the teleogical principle prevails in the female ſex, where the final uſe or purpoſe of the glands is diſcerned; and theſe parts are formed in the male, merely as rudiments in compliance with the mechanical principle.

The *vagina* is about one inch and a half long, and very extenſile: it follows a tortuous courſe.

The *uterus* is about the ſame length, but larger, and thicker in its parietes; and folded internally. (See note (F).

The *oviductus* (in French *la portiére)* appears like a continuation of the laſt mentioned part: it is about one foot and a half long, convoluted like an inteſtine, and, though ſlightly contracted at intervals, on the whole conical, ſo that it decreaſes in diameter to the infundibulum. Its internal coat is covered with innumerable papillæ, which ſecrete the white of the egg; and the whole tube is connected above to the ſpine by a kind of meſentery (*meſometrium* or *meſeræon uteri)*.

It opens by its ſmall end into the *infundibulum*, which is an expanded part, analogous to the fimbriated extremity of the Fallopian tube, for receiving the yolk from the ovarium. This infundibulum is formed of a delicate membrane, with a very elegantly folded margin; which is connected behind to the uterus by means of a round tendinous cord.

§ 342. The *ovarium*, reſembling in its appearance a bunch of grapes, lies under the liver, and contains in a young laying hen about five hundred yolks, varying in ſize from a pin's head, to their perfect magnitude: the largeſt always occupy the external circumference of the part. Each yolk is incloſed in a membrane *(calyx)* which is joined to the ovarium by means of a ſhort ſtalk or pedicle (*petiolus*). A white ſhining line forms on the calyx, when the yolk has attained its complete magnitude. The membrane burſting in this part, the contained yolk eſcapes, and is taken up by the infundibulum in a manner, which we cannot eaſily conceive[7]. It then paſſes along the oviduct, and acquires in its paſſage the white and ſhell. The calyx on the contrary remains connected to the ovarium; but it contracts and diminiſhes in ſize, ſo that in old hens, which have done laying, the whole internal organs of generation nearly diſappear.

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[7] WEPFER *Cicutæ aquaticæ Hiſtoria et Noxæ*. p. 173.

This forms one of the many inſtances in the animal economy, of remarkable and peculiar motions, which cannot be referred to any of the general vital and motive powers, as contractility, irritability, &c. according to the phyſiological notions, which have been hitherto affixed to thoſe terms. Hence I have arranged them as ſpecimens of a peculiar principle or *vita propria*, without preſuming to give any explanation of the ſubject. This term will ſerve to denote and diſtinguiſh them until the received opinions on the above-mentioned general vital powers ſhall have been ſo far altered or modified, as to include theſe peculiar caſes. I have entered more fully into this ſubject in my "*Curæ iteratæ de vi vitali ſanguini denegandâ, vitâ autem propriâ ſolidis quibuſdam Corporis Humani partibus adſerendâ.* Goettingen. 1795, 4to.

(C) AMPHIBIA.

§ 343. The tortoiſe has a manifeſt clitoris, lying in the cloaca. The uterus, oviduct and ovarium have on the whole much analogy with thoſe of birds; but all theſe parts are double, and have two openings into the cloaca[8]. The two uteri are thick and fleſhy, while the oviducts are thin and delicate.

§ 344. The frogs of this country have a large uterus divided by an internal partition into two cavities, from which two long convoluted oviducts ariſe, and terminate by open orifices at the ſides of the heart. The ovaria lie under the liver, ſo that it is difficult to conceive how the ova get into the above mentioned openings. The uterus opens into the cloaca[9].

The toads have not the large uterus; but their oviducts terminate by a common tube in the cloaca[10].

§ 345. The lizards of this country have on the whole a ſimilar ſtructure to that of the laſt mentioned animals. Their oviducts are larger, but ſhorter, and the ovaria contain fewer ova.

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[8] CALDESI, tab. 6, fig. 9, 10.

[9] RÖSEL, tab. 6, fig. 2, tab. 7, 8.

[10] Ibid. tab. 21, fig. 24.

The ſtructure is the ſame in the *rana pipa* (Surinam toad). See CAMPER's *Smaller Writings*, vol. 1, pt. 1, tab. 3, fig. 1.

§ 346. Female ſerpents have double external openings of the genitals for the reception of the double organs of the male (ſee § 346). The oviducts are long and much convoluted. The ovaria reſemble rows of beads, compoſed of yellow veſicles.

(D) FISHES.

§ 347. We ſhall take the torpedo and the carp as examples of the two chief diviſions of the claſs, as we did in ſpeaking of the male organs [11].

In the former fiſh [12] there are two uteri, communicating with the cloaca by means of a common vagina. The oviducts form one infundibulum, which receives the ova as they ſucceſſively arrive at maturity. Theſe are very large in compariſon with thoſe of the bony fiſhes. The yolk, in its paſſage through the oviduct, acquires its albumen, and ſhell. The latter is of a horny conſiſtence, and is known by the name of the ſea-mouſe[13]. It has an elongated quadrangular figure, and its four corners are curved and pointed in the ſkate, while they form horny plaited eminences in the ſharks[14]. The ſecretion of the albumen, and the formation of the ſhell are performed by the papillous internal ſurface of the duct; and chiefly by two glandular ſwellings which appear towards its anterior extremity in the ſummer months, while the eggs are being laid[15].

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[11] CAVOLINI, *loco citato.*

[12] LORENZINI, tab. 3, fig. 1, 2, alſo MONRO's *Phyſiology of Fiſhes*, tab. 2 and 13, of the ſkate.

The ſtructure is much more ſimple in the carp, and probably alſo in the other oviparous bony fiſhes. The two roes occupy the ſame poſition as the ſoft roe of the male does (§ 327). They are placed at the ſide of the inteſtines, liver, and ſwimming bladder, as far as the anus. They conſiſt of a delicate membrane incloſing the ova, which are all of one ſize, and extremely numerous (more than 200,000 in the carp); and terminate by a common opening behind the anus[16]. (See note (G).

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[13] W. G. Tilesius, *on the horny Eggs of Fiſhes, or Sea-mice, as they are commonly called.* Leipzig. 1802, 4to. tab. 4, 5.

[14] J. Hermann, *Tabula Affinitatum Animalium,* p. 279.

[15] Theſe temporary organs were known to Aristotle, who called them breaſts. See alſo Rondelet *de piſcibus marinis,* p. 380. Collins, vol. 2, tab. 43. Monro and Tilesius, *loc. citat.*

[16] Petit, *loc. citat.*

(E) In-

(E) INSECTS.

§ 348. We ſhall here notice the two ſpecies only, which were mentioned in the former chapter[17].

Each of the large ovaria of the *gryllus verrucivorus* contains about fifty ova diſpoſed in bundles. The two organs are connected together at their poſterior extremities, and open between the two ſheaths of a part by which they are diſcharged from the body[18].

In the ſilkworm moth[19] on the contrary, the ovarium reſembles four rows of pearls: each row contains about ſixty ova, which are laid from the end of the abdomen after paſſing through a ſhort duct, which has, however, connected with it ſeveral veſicular proceſſes of uncertain uſe.

(F) VERMES.

§ 349. We ſhall deſcribe here the female genitals of thoſe two animals only, whoſe male organs were noticed in the preceding chapter[20].

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[17] In the works quoted in note 12, § 328, delineations of the female organs of generation of the inſects there mentioned, will be found.

[18] RÖSEL, *loc. citat.* tab. 9, fig. 3.

[19] MALPIGHI, tab. 12, fig. 1, 2.

[20] For an account of theſe parts in ſome other genera, ſee the works quoted in note 15, § 329.

The opening of the genitals of the female roundworm *(aſcaris lumbricoides)* is ſituated near the middle of the body, and leads to a ſhort canal, which divides into two tubes. Theſe gradually contract into two ſlender threadlike oviducts; which are very long and variouſly convoluted [1]. It happens occaſionally that the integuments of the worm burſt and ſome turns of the duct protrude: theſe have been miſtaken for young worms, and have given riſe to the erroneous notion that the animal is viviparous. (See note (H).

The ſtructure of the parts is very ſimple in the cuttle-fiſh. There are two ovaria, containing ova of various ſizes; and a common tube leading to the anus [2]. (For an account of the organs of generation in ſome others of the lower claſſes, ſee note (K).

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[1] Tyson in the *Philoſ. Tranſ.* vol. 13, fig. 2, or in his works. London, 4to. 1751.

(The ſame parts have alſo been repreſented by Dr. Hooper, in the *Memoirs of the London Medical Society*, vol. 5, and by Dr. Baillie in his elegant *Faſciculi of Morbid Anatomy.* Faſcic. 4, pl. 9, fig. 3 and 5. T.)

[2] Turb. Needham, *Nouvelles Obſ. Microſc.* tab. 2.

Compare with this, the delineations by Lister, which indeed are ſomewhat different. *Conchylior. bivalv. exercit. Anat. Tertia.* Lond. 1696, 4to. tab. 1, fig. 10; and by Swammerdam, tab. 52, fig. 10.

Additional Notes to the Twenty-fourth Chapter.

(A) *Ovaria* are found in the females of all animals where the male poſſeſſes *teſticles*: but their ſtructure is in general more ſimple than that of the latter glands, particularly in the firſt claſs. Theſe bodies were formerly called the *female teſticles*; but the term *ovary* is much preferable, as it denotes the function which the parts perform in the animal economy. For, if the office of theſe bodies be at all dubious, when their ſtructure is conſidered in man and moſt of the mammalia; their organization is ſo evident in the other claſſes, that no doubt can be entertained reſpecting their phyſiology. It is manifeſt in all theſe, that the ovaria ſerve for the growth and preſervation of the germs or ova, which exiſt in theſe, bodies, completely formed before the act of copulation. Analogy leads us to conclude that theſe bodies have the ſame office in the mammalia; and thus our explanation and illuſtration of this moſt intereſting part of phyſiology are entirely derived from reſearches in comparative anatomy.

(B) In conſequence of the horizontal poſition of the body of quadrupeds, the clitoris is at the under margin of the orifice of the vagina, inſtead of the upper one, as in women.

It is much larger in the ſimiæ than in women. The *Lemur* (macauco), the carnivora, and moſt of the rodentia have it alſo very large.

None of the mammalia poſſeſs nymphæ; and there is general merely a thin border of the integuments inſtead of labia pudendi.

(C) Cuvier conſiders the opening of the urethra as forming the diſtinction in quadrupeds between the *vulva* and the *vagina;* now this aperture is ſituated in many animals at a conſiderable diſtance within the external opening of the genitals.

There is a contracted circle in this ſituation in the otter, dog, cat, and ruminating animals, which he conſiders as analogous to the hymen. He mentions alſo the exiſtence of a conſiderable fold in the bear and hyena, in this ſituation; and that he has found a manifeſt hymen in the hyrax. According to the ſame author, the mare and aſs, and ſome of the ſimiæ have an analogous ſtructure. Hence, he concludes, that the hymen is not a part excluſively peculiar to the human ſpecies. *Leçons d'Anat. comp.* tom. 5, p. 128, 133. It appears, however, clearly from his own deſcriptions that the parts in the above-mentioned animals only bear a remote reſemblance to the human hymen.

(D) As the proceſs of generation in theſe ſingular animals deviates very conſiderably, in ſome of its parts, from the ſame function as obſerved in the other mammalia, a conſiderable difference is found in the generative organs: of which, as the ſubject is a very intereſting one, I ſhall preſent the reader with a more detailed deſcription, from the paper of Mr. Home, in the Philoſophical Tranſactions for 1795.

" The vagina (of the kanguroo) is about an inch and a half in length, beyond which it is divided into two ſeparate canals, and on the ridge, which lies between them, opens the meatus urinarius.

" Theſe two canals are extremely narrow for about a quarter of an inch in length, and their coats at this part very thick, but afterwards they become more dilated; they diverge in their courſe, and paſs upwards for nearly four inches in length; they then bend towards each other, ſo as to terminate laterally in the two angles of the fundus of the uterus, of which they appear to be an uniform continuation,

" The uterus itſelf is extremely thin and membranous, and its coats infundibular in its ſhape, and ſituated in the middle ſpace between theſe canals; it is largeſt at its fundus, and becomes ſmaller and ſmaller towards the meatus urinarius, where it terminates; the uterus at that part in the virgin ſtate being impervious.

" The ſame internal membrane appears to be continued over the inner ſurface of the uterus and lateral canals; it is thrown into ſeveral folds, forming longitudinal projecting ridges; one of theſe conſtitutes a middle line, extending the whole length of the uterus, and dividing it into two equal parts.

" The ovaria, as well as the fimbriæ, both in appearance and ſituation, reſemble thoſe of other quadrupeds; the fallopian tubes follow nearly the ſame courſe to the uterus, but a little way before they reach it they dilate conſiderably, forming an oval cavity; the coats of this part are alſo much thicker than thoſe of the reſt of the canal, and they are ſupplied with an unuſual number of blood-veſſels, giving theſe cavities a glandular appearance. The fallopian tubes after having formed theſe oval enlargements contract again, and paſs perpendicularly through the coats of the uterus at its fundus, and terminate in two projecting orifices, one on each ſide of the ridge formed by a fold of the internal membrane.

" In the impregnated ſtate, the uterus, and two lateral canals have their cavities very much increaſed in ſize; but that of the uterus is the moſt enlarged: the communication between theſe canals and the vagina is completely cut off, by the conſtricted parts cloſe to the vagina being filled with a thick inſpiſſated mucus; and in this ſtate of the parts there is an orifice very diſtinctly to be ſeen, cloſe to the meatus urinarius, large enough to admit a hog's briſtle, leading directly into the uterus,

rus, where in the virgin ſtate no ſuch paſſage could be obſerved.

" Immediately after parturition, the parts are nearly brought back into their original ſtate: the only circumſtance deſerving of notice is, that the opening leading directly from the uterus to the vagina, which is not met with in the virgin ſtate, after being enlarged by the paſſage of the fœtus, forms a projecting orifice, and almoſt wholly conceals the meatus urinarius.

" Were we to conſider the uterus and its appendages in the unimpregnated ſtate, the two lateral canals would appear to be the proper vagina, particularly as they begin at the meatus urinarius, which is commonly placed at the entrance of the proper, or true vagina, and receive the penis in coition, the end of which is pointed to fit it for that purpoſe; in ſome ſpecies of the opoſſum the male has a double glans, each of them pointed, and diverging from the other, ſo as to enter both canals. But when we find theſe canals in the impregnated ſtate, forming with the uterus one general reſervoir of nouriſhment for the fœtus, and all communication during that period between them and the vagina cut off, we conſider them more immediately as appendages to the uterus than the vagina."

In the opoſſum *(didelphis marſupialis)*, the vagina divides, as it approaches the uterus, into two tubes: and the meatus urinarius opens at the point of diviſion. From each tube a canal commences, which runs outwards, and then returns in the ſame courſe to open into a middle cavity; from which the cornua uteri ariſe. The changes which theſe parts undergo in the impregnated ſtate have not hitherto been aſcertained.

(E) The paſſage of the fœtus, in the opoſſum tribe and the kanguroo, from the cavity of the uterus into the falſe belly, where it adheres by its mouth to the nipple, preſents one of the moſt ſingular and intereſting phenomena in the whole circle of comparative anatomy. Phyſiologiſts have not yet aſcertained, whether the embryo poſſeſſes, at any period, a connection with the uterus ſimilar to that which is obſerved in the other mammalia: but it appears very probable, that the proceſſes, which follow the paſſage of the ovum from the ovarium, are entirely different in theſe animals, from thoſe which take place in the other mammalia. Neither has the preciſe period, at which the fœtus enters the falſe belly, been hitherto ſhewn.

The following ſtatement of the ſubject, as far as it is at preſent known, is derived from Mr. Home's paper.

The uterus and lateral canals, in their pregnant ſtate, are diſtended with a very adheſive jelly of a bluiſh white colour; which alſo fills the oval enlargements of the fallopian tubes.

" In the cavity of the uterus, ſays Mr. HOME, I detected a ſubſtance, which appeared organized; it was enveloped in the gelatinous matter, and ſo ſmall as to make it difficult to form a judgment reſpecting it; but when compared with the fœtus after it becomes attached to the nipple, it ſo exactly reſembled the backbone with the poſterior part of the ſkull, that it is readily recognized to be the ſame parts in an earlier ſtage of their formation."

This ſubſtance is repreſented in plate 20, fig. 2; but the engraving does not, in my opinion, poſſeſs the ſlighteſt ſimilitude to the parts mentioned by Mr. HOME.

The ſize of the fœtus at the time it leaves the uterus is not yet aſcertained. The ſmalleſt, which has been hitherto found in the falſe belly, weighed twenty-one grains; and was leſs than an inch in length. In another inſtance it was " thirty-one grains in weight, from a mother of fifty-ſix pounds. In this inſtance the nipple was ſo ſhort a way in the mouth, that it readily dropped out, we muſt therefore conclude that it had been very recently attached to it.

" The fœtus at this period had no navel ſtring, nor any remains of there ever having been one; it could not be ſaid to be perfectly formed, but thoſe parts which fit it to lay hold of the nipple were more ſo than the reſt of the body. The mouth was a round hole, juſt enough to receive the point of the nipple; the two fore-paws, when compared to the reſt of the body, were large and ſtrong, the little claws extremely diſtinct; while the hind-legs, which are afterwards to be ſo very large, were both ſhorter and ſmaller than the fore ones."

"The mode in which the young kanguroo paſſes from the uterus into the falſe belly, has been matter of much ſpeculation; and it has even been ſuppoſed that there was an internal communication between theſe cavities; but after the moſt diligent ſearch, I think I may venture to aſſert that there is no ſuch paſſage. This idea took its riſe from their being no viſible opening between the uterus and vagina, in the unimpregnated ſtate; but ſuch an opening being very apparent, both during pregnancy, and after parturition, overturns this hypotheſis; for we cannot ſuppoſe that the fœtus, when it has reached the vagina, can paſs out in any other way than through the external part." This paſſage will be facilitated by the power which the animal poſſeſſes of drawing down the falſe belly to the vulva, which has naturally a conſiderable projection.

(F) In ſpeaking of the uterus and vagina of birds, the author does not ſufficiently keep up the diſtinction which ought to be obſerved between an *uterus* and an *oviduct*.

The germ, or ovum, paſſes from the ovarium through a canal, which either conveys it out of the body, (as in the caſe of the egg) or tranſmits it into another organ. The latter is a cavity, admitting of enlargement, and having the germ attached to its parietes by means of veſſels, which nouriſh and preſerve it, until it has acquired a certain development.

The firſt mentioned organs are found in all the four claſſes of vertebral animals: they are called *fallopian tubes* in the mammalia; and *oviducts* in the three other claſſes. The latter belongs to the mammalia only, and is their *uterus*. We find, however, that the author ſpeaks of the uterus of other claſſes: the difference in the office of the parts is ſo ſtriking that they ſhould on no account be confounded together.

(G) The ovaria of fiſhes generally contain a very large number of ova, ſo as to account to us ſatisfactorily for the aſtoniſhing multitudes in which ſome ſpecies are formed. In a perch weighing one pound two ounces, there were 69,216 ova in the ovarium: in a mackarel of one pound three ounces, 129,200: in a carp of eighteen inches Petit found 342,144: and in a ſturgeon of one hundred and ſixty pounds, there was the enormous number of 1,467,500.

(H) The genital tubes of the aſcaris contain a milky fluid, which, when examined by the microſcope, is found to contain numerous ova.

The *aſcaris vernicularis* poſſeſſes a genital apparatus of the ſame appearance with that of the *lumbricoides*. Dr. HOOPER in *Trans. of the Lond. Med. Soc.*

(I) The ova of the cuttle-fiſh, when diſcharged from the body, are connected into bunches, exactly reſembling grapes, by a tenacious and ductile ſubſtance. The ſimilarity is ſo ſtriking as to have given riſe to the term of *ſea-grapes*, which is applied to them in common language. In the *ſepia octopus* and *loligo* (calmar) they form ſmall maſſes.

(K) Moſt of the gaſteropodous molluſca are true hermaphrodites, and have the male and female organs of generation united in the ſame individual: but they copulate, ſo that each fecundates, and is fecundated. The common ſlug *(limax)* and ſnail *(helix)* afford the moſt familiar examples of this ſtructure. They poſſeſs an ovarium, oviduct, teſtis, vas deferens, and penis. The oviduct and vas deferens open into a cavity ſituated under the right ſuperior horn; and the penis is contained in the ſame cavity. The latter part enters the oviduct of the other animal at the time of copulation.

The ſnail has, in addition to theſe organs, a very ſingular one, the uſe of which is quite obſcure. It conſiſts of a cavity with an eminence at bottom; from which a ſharp pointed, thin, calcareous body proceeds. This can be thruſt forth from the cavity, and is employed by the ſnails to prick each other before the act of copulation.

In the acephalous molluſca, ſuch as the oyſter, muſcle, &c. there is no diſcernible organ of generation, except an ovarium, which varies in ſize and colour at different periods of geſtation.

The ſame obſervation holds good alſo of the *aſterias* (ſtar-fiſh) and *echinus* (ſea-urchin). In both theſe genera the ovaria conſiſt of ſeveral diſtinct maſſes of ova.

The proceſs of generation in the zoophytes reſembles the growth of buds and branches in trees; and therefore theſe animals contain no generative organs, nor have any diſtinction of ſex. This is the caſe in the polype (*hydra*) and the ſea anemone (*actinia*); where the young ſhoot out from any part of the ſurface of the parent. If theſe animals are cut in two, the divided portions will form perfect animals.

CHAPTER XXV.

ON THE FŒTUS OF THE MAMMALIA, AND THE ORGANS WITH WHICH IT IS CONNECTED[1].

§ 350. THE firſt parts which can be diſcerned in the uterus after impregnation, are the membranes *(involucra)* of the ovum; in which the embryo itſelf becomes viſible after a certain period. By means of the navel-ſtring the fœtus is connected to theſe membranes, and conſequently to the uterus of the mother; from which its nouriſhment is derived until the time of birth. It will, therefore, be the natural method to paſs from the deſcription of the uterus, to that of the membranes, and other parts of the after birth; and to conſider in the laſt place whatever may be worthy of remark concerning the embryo itſelf.

§ 351. The mode of connection of the pregnant uterus with the membranes of the ovum, and thereby with the embryo itſelf, diſplays three chief differences in the various mammalia.

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[1] Much information on the ſubject of this, and of the laſt chapter, is contained in Dr. J. F. LOBSTEIN's *Eſſai ſur la Nutrition du Fœtus.* Straſb. 1802, 4to.

Either the whole external ſurface of the ovum adheres to the cavity of the uterus; or the connection is effected by means of a ſimple *placenta*; or by more numerous ſmall placentæ (*cotyledons*).

§ 352. The firſt kind of ſtructure is obſerved in the ſow[2]; and is ſtill more manifeſt in the mare. In the latter caſe, the external membrane of the ovum, the chorion, may be ſaid to form a bag-like placenta. Numerous and large branches of the umbilical veſſels ramify through it, particularly in the latter half of the period of pregnancy; and its external ſurface is covered with innumerable flocculent papillæ, which connect it to the inſide of the uterus[3].

§ 353. In thoſe animals of this claſs, where the embryo is nouriſhed by means of a placenta, remarkable varieties occur in the ſeveral ſpecies; ſometimes in the form and ſucceſſive changes of the part; ſometimes in the ſtructure of the organ as being more ſimple or complicated.

In moſt of the digitated mammalia, as well as in the quadrumana, the placenta has a roundiſh form[4]; yet it conſiſts ſometimes of two halves lying near together; and in the dog, cat, martin, &c. it reſembles a belt (*cingulum* or *zona*[5]). Its form in the pole-cat holds the middle between theſe two ſtructures; as there are two round maſſes joined by an intervening narrower portion[6].

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[2] FAB. AB AQUAPEND. tab. 25 and 26. DAUBENTON, tom. 5, tab. 21, 22.

[3] FAB. AB AQUAPEND. tab. 21, 22; tab 23, fig. 46.

I have diſcovered a moſt remarkable inſtance of change in the form of this organ, in the hedge-hog. For ſome weeks after impregnation, the placenta includes nearly the whole circumference of the chorion, and may be compared, in ſize and form, to a hazel-nut. It is ſpongy and vaſcular internally; but on the outer ſurface firm and tough, and approaching to cartilaginous hardneſs. It is not, however, of uniform ſtrength throughout; but thinner and more flexible towards the concave ſide of the cornua uteri, than on the oppoſite part. As pregnancy advances, this thinner portion increaſes, and gradually aſſumes a nearly membranous ſtructure, while the oppoſite thick part forms a firm and denſe placenta of a ſaddle-like ſhape with extenuated margins. This lies in the more mature fœtus nearly acroſs the ilia; ſo that the neighbouring parts are protected from any injury, which might have ariſen from accidental preſſure. For the final purpoſe of this ſingular, and, as far as I know, unique conſtruction, is the preſervation of the tender embryo in the abdomen of an animal, which rolls itſelf up with ſuch force, that without this proviſion, the pregnant uterus and its contents would be expoſed to a moſt dangerous preſſure.

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[4] DAUBENTON, tom. 7, tab. 38, fig. 3, 4, of the rat. Ibid. tab. 40, fig. 7, 8, of the domeſtic mouſe; tom. 8, tab. 13, fig. 6, of the mole.

[5] It is repreſented in the dog, by EUSTACHIUS, tab. anatom. tab. 14, fig. 7, 8, by FAB. AB. AQUAPEND. tab. 27, 28, and by DAUBENTON, tom. 5, tab. 50.

In the cat, by NEEDHAM, *de Formato Fœtu*, tab. 4, fig. 1, and DAUBENTON, tom. 6, tab. 6.

In the martin, ibid. tom. 7, tab. 20.

[6] Ibid. tom. 7, tab. 27.

In ſeveral ſpecies of digitated mammalia the external ſurface of the placenta is provided with a white and apparently glandular body (*corpus glandulosum* EVERARDI[7], or *ſubplacenta*), ſmaller than the proper placenta, by which it is incloſed[8]. In proportion as the embryo becomes more mature, this part admits of more eaſy ſeparation from the placenta.

§ 354. The placenta of the *biſulca* is divided into numerous *cotyledons*; the ſtructure of which is very intereſting, as it elucidates the whole phyſiology of this organ. The parts deſignated by this appellation are certain fleſhy excreſcences (*glandulæ uterinæ*), produced from the ſurface of the impregnated uterus, and having a correſponding number of flocculent faſciculi of blood-veſſels (*carunculæ*), which grow from the external ſurface of the chorion, implanted in them. Thus the *uterine* and *fetal* portions of the placenta are manifeſtly diſtinct from each other, and are eaſily ſeparable as the fœtus advances to maturity. The latter only are diſcharged with the after-birth, while the former, or the cotyledons, gradually diſappear from the ſurface of the uterus after it has parted with its contents. The number and form of theſe excreſcences vary in the different genera and ſpecies. In the ſheep and cow they ſometimes amount to a hundred. In the former animal and the goat, they are, as the name implies, concave eminences[9]; while on the contrary, in the cow, deer, &c. their ſurface is rounded or convex[10].

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[7] *Coſmopolitæ Hiſtoria Naturalis*, 1686. 12, p. 60.

[8] In the hare it is repreſented by DAUBENTON, tom. 6, tab. 46.

In the rabbit by NEEDHAM, tab. 3, and DE GRAAF, tab. 26, 27.

In the guinea-pig by FAB. AB. AQUAP. tab. 30, and DAUBENTON, tom. 8, tab. 4, fig. 6.

In the water-rat, ibid. tom. 7, tab. 46, fig. 4, 5.

§ 355. The trunks of the veins which paſs from the placenta or carunculæ, and of the arteries which proceed towards theſe parts, are united in the *umbilical* chord, which is longer in the human embryo [11], than in any other animal.

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[9] For a view of theſe parts in the ſheep, ſee FAB. AB. AQUAP. tab. 12, 14, 15.

[10] In the cow, HOBOKEN: particularly fig. 14, to 17. In the goat, DAUBENTON, tom, 6, tab. 17.

In the foal, as in the child, the chord poſſeſſes a ſingle umbilical vein [12]; whilſt moſt other quadrupeds have two, which unite, however, into a common trunk near the body of the fœtus, or juſt within it [13].

§ 356. The amnion, or innermoſt of the two membranes of the ovum, which belongs to the pregnant woman, as well as to the mammalia, is diſtinguiſhed in ſome of the latter, as for inſtance in the cow, by its numerous blood-veſſels; while on the contrary, in the human ſubject it poſſeſſes no diſcernible vaſcular ramification.

§ 357. Between the chorion and amnion there is a part found in moſt pregnant quadrupeds, and even in the cetacea, which does not belong to the human ovum; viz. the *allantois* or *urinary membrane*. The latter name is derived from the connection, which this part has, by means of the

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[11] The pole-cat probably has the ſhorteſt chord. DAUBENTON, tom. 7, tab. 27, fig. 3.

[12] RUINI, p. 189.

[13] HOBOKEN, fig. 23, 27, in the calf.

urachus, with the urinary bladder of the fœtus; whence the watery fluid, which it contains, has been regarded as the urine of the animal. The term *allantois* has ariſen from the ſauſage-like form, which the part poſſeſſes in the biſulca and the pig[14]; although this ſhape is not found in ſeveral other genera and ſpecies. Thus in the hare, rabbit, guinea-pig, &c. it reſembles a ſmall flaſk; and it is oval in the pole-cat. It covers the whole internal ſurface of the chorion in the *ſolidungula*, and therefore, incloſes the foal with its amnion. It contains moſt frequently in theſe animals (although not rarely in the cow), larger or ſmaller maſſes of an apparently coagulated ſediment in various forms and number, which has been long known by the ſingular name of the *horſe-venom* or *hippomanes*[15].

Some orders and genera of mammalia reſemble the human ſubject in having no allantois; as the *quadrumana* and the hedge-hog: nay, in the latter animal, the urinary bladder has no trace whatever of urachus; which even exiſts in a certain degree in the human ſubject; but its fundus is perfectly ſpherical in the fœtus.

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[14] FAB. AB. AQUAP. tab. 13, fig. 29, and tab. 17, fig. 37, in the ſheep. J. C. KUHLEMANN has repreſented this part in an embryo of the 19th day after conception. *Obſerv. circa Negotium Generationis in Ovibus.* Götting. 1753, 4to. tab. 2, fig. 1, 2.

HOBOKEN, fig. 10 to 13 and 15, in the cow. FABRIC. tab. 25, in the pig.

[15] DAUBENTON, tom. 4, tab. 9, fig. 1, 2, of the horſe.

HOBOKEN, fig. 19, 21, and fig. 37, of the cow.

§ 358. There is on the contrary in this animal, as well as in the dog, cat, and others, a peculiar part called the *tunica erythroides*, ſituated between the chorion and amnion like the allantois, for which it might eaſily be miſtaken on the firſt view. It contains a watery fluid at the commencement of pregnancy, but is eaſily diſtinguiſhed from an allantois, as it is not joined to the fundus of the bladder by the urachus, but is connected by means of the *omphalomeſenteric veins* with the meſenteric blood-veſſels of the fœtus[16]. This connection conſtitutes a reſemblance on one hand to the yolk-bag of the incubated bird, and on the other ſide to that remarkable *veſicula umbilicalis*, which is obſervable in the early months of pregnancy[17]. The *tunica erythroides*, as well as that veſicula are moſt complete in young embryos, and are, on the contrary, ſo diminiſhed in ſubſequent periods, that their functions muſt be connected with the earlier ſtages of exiſtence.

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[16] Fab. ab. Aquap. tab. 1, of the dog.
Needham, tab. 4, fig. 1, of the cat.

[17] *Comment. Soc. Reg. Scient.* Gotting. vol. 9, p. 128, fig. 1.

§ 359. The firſt trace of the formation of an embryo cannot be diſcovered in the different ſpecies of this claſs until a conſiderable time after conception. The original formation, as in the human ſubject, is widely diſtant from the ſubſequent perfection of the mature fœtus [18]: and the growth and formation of the members, inſtead of proceeding alike in the whole claſs, are ſo ordered in particular ſpecies, that thoſe external organs, which are moſt neceſſary to the young animal, according to its peculiar mode of life, are formed and completed the ſooneſt. Hence ariſes the great ſize of the poſterior hands of the fœtal *quadrumana*, of the feet of the ſquirrel, of ſuch animals in ſhort as are deſtined to live in trees; likewiſe of thoſe of the foal and kid, which are obliged to uſe their legs immediately after birth [19], when compared with the correſponding parts of the mature human fœtus [20].

§ 360.

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[18] See delineations of the embryo of different animals in the early periods: viz. of the rabbit in De Graaf, tab. 26, fig. 8-10, and in Haller, *Oper. Minor*, tom. 3, tab. 21, fig. 1-4. Of the ſheep in Kuhlemann, tab. 2.

[19] In the fœtal kanguroo, in that ſtate at leaſt, in which it is firſt found in the falſe belly, the fore-feet are much larger and ſtronger than the poſterior ones, on account of the uſe, to which the animal puts them in holding by the nipple. When the animal in a more mature ſtate is in a manner born a ſecond time, and muſt ſoon be left to itſelf, the poſterior limbs increaſe to their well-known enormous magnitude.

[20] The erroneous obſervation concerning the ſuppoſed unſhape-

§ 360. The moſt important points, in which the fœtus of the mammalia differs from that of the human ſubject, have been already noticed. In other reſpects their ſtructure ſeems to correſpond [1]; at leaſt, for inſtance, in the membrana pupillaris [2], in the thymus, thyroid, and ſupernatural glands. Some trivial points of diſtinction are not noticed; ſuch as the meconium reſembling hard ſcybala in in the biſulca, and animals of the mouſe-kind [3], &c.

ſhapelineſs of the fœtus of the bear, which has been ſo often made ſince the time of Aristotle, would not require an expreſs refutation in the preſent day, had it not been repeated by ſome modern zoologiſts, whoſe accuracy in general is much to be relied on. I have completely ſhewn how unfounded this ſuppoſition is, by the repreſentation of a young bear's fœtus in the 4th vol. of the *Delineations of Objects relating to Natural Hiſtory*, tab. 32; and it appears to be very completely formed.

[1] There is a view of the viſcera of a fœtal horſe, in Ruini, p. 189, and in Daubenton, tom. 4, tab. 7.

Of the ſheep in Kuhlemann, tab. 2, fig. 8.

Of the calf by Hoboken, fig. 24-25.

Wrisberg in the *Nov. Comment. Soc. Reg. Scient.* Goetting. tom. 2, p. 207.

[3] Fleming's *German Huntſman*, p. 130, and Harvey *de Generat. Animal*, p. 197.

CHAPTER XXVI.

ON THE BREASTS AND TEATS OF THE MAMMALIA.

§ 361. THE nouriſhment of the young animal immediately after birth, is derived in this claſs from the milk of the mother, which is ſecreted in the *breaſts*. This ſecretion, which is peculiar to the claſs in queſtion, has given riſe to the name *mammalia*, by which LINNEUS has diſtinguiſhed them. Yet no teats have been hitherto diſcovered in the ornithorhynchus[1]: and they ſeem alſo to be wanting in the males of ſome other ſpecies, as the hamſter, and *lemur mongoz*; although this ſex poſſeſſes them in general as well as the female[2]. They are ſometimes however found in ſmaller number in the former ſex, as in the dog; or in a different ſituation, as in the horſe[3].

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[1] HOME, in the *Philoſ. Tranſ.* 1802, p. 69.

[2] Numerous inſtances have occurred, in which milk has been ſecreted in the breaſts of male animals, as the goat, ox, dog, cat, and hare, as well as in men. I have treated more particularly of this phyſiological phenomenon in deſcribing a goat, which it was neceſſary to milk every other day for the ſpace of a year; in the *Hanoverian Magazine*, 1787, p. 753.

Milk is commonly found in the breaſts of newly born children of both ſexes; and the ſame obſervation holds good in the foal and calf.

§ 362. The poſition and number of the teats varies conſiderably in the different ſpecies. Several irregularities occur in the latter point, particularly among the domeſtic animals[4]. Numerous exceptions muſt be made in ſome ſpecies, as the domeſtic ſow, the guinea-pig, and others, to the general rule, which aſſigns to animals twice as many teats as the number of young, which they ordinarily produce.

Their ſituation is the moſt ſingular in the female marſupial animals; where their exiſtence can ſcarcely be recognized except at the time when the young are actually contained in the abdominal pouch, or falſe belly[5]. (See note (A) at the end of the chapter.)

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[3] DAUBENTON in FOURCROY's *Médecine eclairée*, tom. 2, p. 274.

"Naturaliſts were long at a loſs to diſcover the mammæ and teats of this animal; in the male they were at length detected by BUFFON, on the ſheath of the penis. Mr. J. HUNTER alſo made the ſame remark, without knowing that BUFFON had previouſly noticed it; theſe teats are largeſt in the fœtus and young foal." REES's *Cyclop.* art. *Anatomy of the Horſe.*

[4] BUFFON, tom. 10, p. 295.

[5] TYSON, who on all other occaſions diſplays the greateſt

§ 363. In the ſingular animals, which have been juſt alluded to, as well as in thoſe which live in the water, or under-ground, the mammary glands, for reaſons which muſt be very obvious, lie flat under the ſkin, and do not project ſo as to form breaſts or udders: neither do the lactiferous ducts poſſeſs ſuch dilatations and cavities as are obſerved in the biſulca, the mare and others[6]. In thoſe animals which have their breaſts placed on the cheſt (*mammæ pectorales*), theſe organs never poſſeſs that form, which ſo peculiarly diſtinguiſhes the human female in the bloom of life. (See note (B) at the end of the chapter.)

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acuteneſs, could diſcover no trace of teats in his female opoſſum. D'ABOVILLE expreſsly aſſerts, that they are formed by the ſuction of the young; that their number, therefore, in animals which are giving ſuck, exactly correſponds to the number of young at that period; and that they are placed without any ſymmetry, being formed wherever the young animals may happen to attach themſelves on their arrival in the abdominal pouch. See *Voyages du Marq.* DE CHASTELLUX *dans l'Amerique Septentrionale*, tom. 2, p. 332.

In an opoſſum which I poſſeſſed for ſeveral years, and whoſe ovaria diſcovered no trace of any previous impregnation, there were three pairs of teats in the falſe belly, very ſmall indeed and flat, but regularly arranged in a half moon.

[6] DAUBENTON, tom. 5, tab. 12, of a goat which had double teats on each udder.

Additional Notes to the Twenty-ſixth Chapter.

(A) The mammæ and teats of the opoſſum tribe, kanguroo, and ſome other animals, are ſituated in a cavity, formed by the common integuments, at the poſterior part of the abdomen. This is generally called the falſe belly. Its margin contains muſcular fibres, which acting like a ſphincter muſcle, cloſe the opening. It is connected to, and ſupported by the pair of bones which ariſe from the pubis, and are deſcribed in the chapter on the ſkeleton.

§ 37. Theſe bones poſſeſs muſcles which depreſs, and others which elevate them; and the falſe belly neceſſarily follows their motions. The ſame bones are found in the ornithorhynchus, where no falſe belly exiſts, and where the mammæ have not hitherto been diſcovered.

The paſſage of the fœtus into this recptacle at a very early period, and its connection to the nipple, have been mentioned in the notes to the twenty-fourth chapter.

It may be further obſerved, that in the kanguroo, the young animal remains in the falſe belly, or enters it occaſionally, long after it ſeems capable of providing for itſelf.

A ſpecies of toad, (the *rana pipa*, or Surinam toad) has a ſtructure ſomewhat analogous to the falſe belly of the marſupial mammalia. There are ſeveral cells, amounting in number to 70 or 80, formed by the integuments of the back of the female. The ova are placed in theſe, and go through their different changes to the formation of the young frog. The integuments, which form theſe cells, appear to have no peculiarity in their organiſation: nor are the cells formed until the time at which they are to receive the ova.

(B) The mammæ of animals are not ſurrounded with that quantity of fat, which is obſerved in the human female: hence they are not very apparent except at the period of ſuckling, when they become diſtended with milk.

Another remarkable difference occurs in the ſtructure of the nipple. This part in women has about fifteen openings, which are the terminations of as many lactiferous tubes. In the other mammalia it is hollow, and has only one or two orifices. Its cavity communicates with two large reſervoirs, in which the lactiferous tubes terminate.

CHAPTER XXVII.

ON THE INCUBATED EGG.

§ 364. THE various vital proceſſes of nutrition and formation, which are carried on in the fœtus of the mammalia, while in its mother's body, and by means of the moſt intimate connexion with the parent, are effected in the incubated chick, by its own powers, quite independently of the mother, and without any extraneous aſſiſtance, except that of the atmoſpheric air, and a certain degree of warmth.

§ 365. The egg is covered, within the ſhell, by a white and firm membrane *(membrana albuminis)*, which contains no blood-veſſels. The two layers of this membrane, which in other parts adhere cloſely to each other, leave at the large end a ſpace, which is filled with atmoſpheric air [1].

This membrane includes the two *whites of the egg;* each of which is ſurrounded by a delicate membrane. The external of theſe is the moſt fluid and tranſparent; the inner one thicker and more opaque: they may be ſeparated in eggs which are boiled hard.

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[1] J. C. Hehl, *Obſervata phyſiologica de Natura et Uſu Aeris, Ovis Avium incluſi.* Tubing. 1796, 4to.

The internal white ſurrounds the yolk, which is contained in a peculiar membrane called the *yolk-bag*. From each end of this proceeds a white knotty body, which terminates in a flocculent extremity in the albumen. Theſe are called the *chalazæ* or *grandines*[2].

A ſmall, round, milk-white ſpot, called the tread of the cock, (*cicatricula* or *macula*), is formed on the ſurface of the yolk-bag. It is ſurrounded by one or more whitiſh concentric circles, (*halones* or *circuli*), the uſe of which, as well as that of the cicatricula itſelf, and of the chalazæ, is not yet aſcertained.

§ 366. We now proceed to notice the wonderful ſucceſſive changes which go on during the incubation of the egg; and the metamorphoſes which are obſerved both in the general form of the chick, and in particular viſcera. The periods of theſe changes will be ſet down from the hen, as affording the moſt familiar example[3]. It will be beſt to give, firſt, a curſory chronological[4] view of the whole proceſs, and then to make a few remarks on ſome of the moſt important parts of the ſubject.

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[2] LEVEILLE diſtinguiſhes a third *white;* and conſiders the chalazæ as abſorbing veſſels floating in it, and deſtined to abſorb it as well as the inner albumen, and mix them with the yolk during incubation. *Sur la Nutrition du Fœtus*, Par. 1799, 8vo.

[3] The following works may be referred to for repreſentations of the formation of the chicken in the egg.

MALPIGHI, *de Formatione Pulli,* Lond, 1673, 4to; alſo, *de Ovo Incubato,* 1686, fol.

W. LANGLY, in SCHRADER, *Obſerv. et Hiſtor. de Generatione*, Amſt. 1674, 12mo.

§ 367. A ſmall ſhining ſpot of an elongated form, with rounded extremities, but narroweſt in the middle, is perceived at the end of the firſt day, not in nor upon the cicatricula, but very near that part on the yolk-bag, (*nidus pulli; colliquamentum; areola pellucida*). This may be ſaid to appear before-hand as the abode of the chick which is to follow.

No trace of the latter can be diſcerned before the beginning of the ſecond day: and then it has an incurvated form, reſembling a gelatinous filament with large extremities, very cloſely ſurrounded by the amnion, which at firſt can ſcarcely be diſtinguiſhed from it.

Ant. Maitre-jan, *Obſervat. ſur la Formation du Poulet*, Par. 1722, 12mo.

C. F. Wolff, *Theoria Generationis*, Hal. 1759, 4to, tab. 2; alſo in the *Nov. Comment. Acad. Petrcpolitan.* tom. 12, 13, and 14.

As the plates of Langly and Wolff repreſent only the earlier periods, and the others are not executed with that elegance and clearneſs which they ought to poſſeſs; I have given in the 4th and 7th parts of my *Delineations of Objects relating to Natnral Hiſtory*, ſome neat and accurate repreſentations, taken from two periods, in which the moſt important phenomena of incubation are moſt clearly diſcernible.

[4] The periods of the different changes are ſet down as I have aſcertained them in my own repeated obſervations.

About this time the halones enlarge their circles; but they ſoon after diſappear entirely, as well as the cicatricula.

§ 368. The firſt appearance of red blood is diſcerned on the ſurface of the yolk-bag, towards the end of the ſecond day. A ſeries of points is obſerved, which form grooves; and theſe, cloſing, conſtitute veſſels, the trunks of which become connected to the chick. The vaſcular ſurface itſelf is called *figura venoſa*, or *area vaſculoſa*: and the veſſel, by which its margin is defined, *vena terminalis*. The trunk of all the veins joins the vena portæ; while the arteries, which ramify on the yolk-bag, ariſe from the meſenteric artery of the chick.

§ 369. On the commencement of the third day, the newly-formed heart (the primary organ of the circulating proceſs, which now commences) is diſcerned by means of its triple pulſation; and conſtitutes a threefold *punctum ſaliens*. Some parts of the incubated chicken are deſtined to undergo ſucceſſive alterations in their form; and this holds good of the heart in particular. In its firſt formation it reſembles a tortuous canal, and conſiſts of three dilatations lying cloſe together, and arranged in a triangle. One of theſe, which is properly the right, is then the common auricle; the other is the only ventricle, but afterwards the left; and the third is the dilated part of the aorta, (*bulbus aortæ*).

About the ſame time, the ſpine, which was originally extended in a ſtraight line, becomes incurvated; and the diſtinction of the vertebræ is very plain. The eyes may be diſtinguiſhed by their black pigment, and comparatively immenſe ſize; and they are afterwards remarkable in conſequence of a peculiar ſlit [5] in the lower part of the iris [6].

§ 370. From the fourth day, when the chicken has attained the length of four lines, and its moſt important abdominal viſcera, as the ſtomach, inteſtines, and liver, are viſible, (the gall bladder, however, does not appear till the ſixth day), a vaſcular membrane *(chorion*, or *membrana umbilicalis)* begins to form about the navel; and encreaſes in the following days with ſuch rapidity, that it covers nearly the whole inner ſurface of the ſhell, within the membrana albuminis, during the latter half of incubation. This ſeems to ſupply the place of the lungs, and to carry on the reſpiratory proceſs inſtead of thoſe organs. The lungs themſelves begin indeed to be formed on the fifth day; but, as in the fœtus of the mammalia, they muſt be quite incapable of performing their functions while the chick is contained in the amnion.

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[5] I have found an exactly ſimilar ſlit in the iris of the common lizard *(lacerta agilis)*, before it had attained maturity. Thus this ſtructure belongs to ſuch animals as have no *membrana pupillaris*.

[6] Malpighi, *de Format. Pulli*, tab. 2. fig. 18—21; and *de Ovo*, tab. 3, fig. 18, 20; tab. 4, fig. 21.

Delineations of Objects, &c. pt. 7, tab. 64.

See alſo Haller, *ſur la Formation du Cœur dans le Poulet*, tom. 1, p. 163—194; tom. 2, p. 160.

§ 371. Voluntary motion is firſt obſerved on the ſixth day; when the chick is about ſeven lines in length.

Oſſification commences on the ninth day; when the oſſific juice is firſt ſecreted, and hardened into bony points *(puncta oſſificationis)*. (See the note to § 5.) Theſe form the rudiments of the bony ring of the ſclerotica, which reſembles at that time a circular row of the moſt delicate pearls [7].

At the ſame period, the marks of the elegant yellow veſſels *(vaſa vitelli lutea)*, on the yolk-bag, begin to be viſible.

On the fourteenth day, the feathers appear; and the animal is now able to open its mouth for air, if taken out of the egg.

On the nineteenth day it is able to utter ſounds; and on the twenty-firſt to break through its priſon, and commence a ſecond life.

§ 372. We ſhall conclude with one or two remarks on thoſe very ſingular membranes, the yolk-bag and chorion, which are ſo eſſential to the life and preſervation of the animal.

The chorion, that moſt ſimple yet moſt perfect temporary ſubſtitute for the lungs, if examined in the latter half of incubation in an egg very cautiouſly opened, preſents, without any artificial injection, one of the moſt ſplendid ſpectacles that occurs in the whole organic creation. It exhibits a ſurface covered with numberleſs ramifications of arterial and venous veſſels. The latter are of the bright ſcarlet colour; as they are carrying oxygenated blood to the chick; the arteries on the contrary are of the deep or livid red, and bring the carbonated blood from the body of the animal[8]. Their trunks are connected with the iliac veſſels; and, on account of the thinneſs of their coats, they afford the beſt microſcopical object for demonſtrating the circulation in a warm-blooded animal.

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[7] I have found this part much more elegantly formed than in the hen, in the incubated pea-fowl of the fourteenth and following days.

§ 373. The other membrane, the *membrana vitelli*, is alſo connected to the body of the chick; but by a two-fold union, and in a very different manner from the former. It is joined to the ſmall inteſtine, by means of the *ductus vitello-inteſtinalis*[9] *(pedunculus, apophyſis)*; and alſo by the blood-veſſels, which have been already mentioned (§ 368), with the meſenteric artery and vena portæ.

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[8] Hence, as is well known, the incubated bird periſhes if the ſhell be varniſhed over; as the reſpiratory proceſs is thereby ſuſpended.

[9] This is regarded by Leveille merely as a ligament. It is well known that no true yolk is diſcoverable in the inteſtine of the incubated chick. Yet ſometimes (not indeed always, but under certain circumſtances not yet ſufficiently underſtood) air will paſs from the inteſtine through this part into the yolk bag. This fact, which was noticed by Haller, and after him by Maitrejan, has occurred alſo to myſelf in a duck of the twenty-ſecond day.

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In the courſe of the incubation the yolk becomes conſtantly thinner and paler by the admixture of the inner white. At the ſame time innumerable fringe-like veſſels with flocculent extremities, of a moſt ſingular and unexampled ſtructure, form on the inner ſurface of the yolk-bag, oppoſite to the yellow ramified marks above-mentioned (§ 371); and hang into the yolk. There can be no doubt that they have the office of abſorbing the yolk, and conveying it into the veins of the yolk-bag[10]; where it is aſſimilated to the blood, and applied to the nutrition of the chick. Thus in the chicken, which has juſt quitted the egg, there is only a remainder of the yolk and its bag to be diſcovered in the abdomen. Theſe are completely removed in the following weeks, ſo that the only remaining trace is a kind of cicatrix on the ſurface of the inteſtine.

The analogous umbilical bag of the fetal-ſhark, (which is found alſo in ſeveral other fiſhes, and ſome reptiles) is connected to the ſmall inteſtine; at leaſt to the *burſa entiana*, which is a peculiar dilatation of the poſterior end of the inteſtine. COLLINS, vol. 2, tab. 33, fig. 2.

[10] In numerous and varied microſcopical examinations of the yolk-bag in the latter weeks of incubation, I think I have obſerved the actual paſſage of the yolk, from the yellow flocculent veſſels of the inner ſurface of the bag, into the blood-veſſels, which go to the chicken. That is, I have ſeen manifeſt yellow ſtreaks in the red blood contained in thoſe veins.

THE END.

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